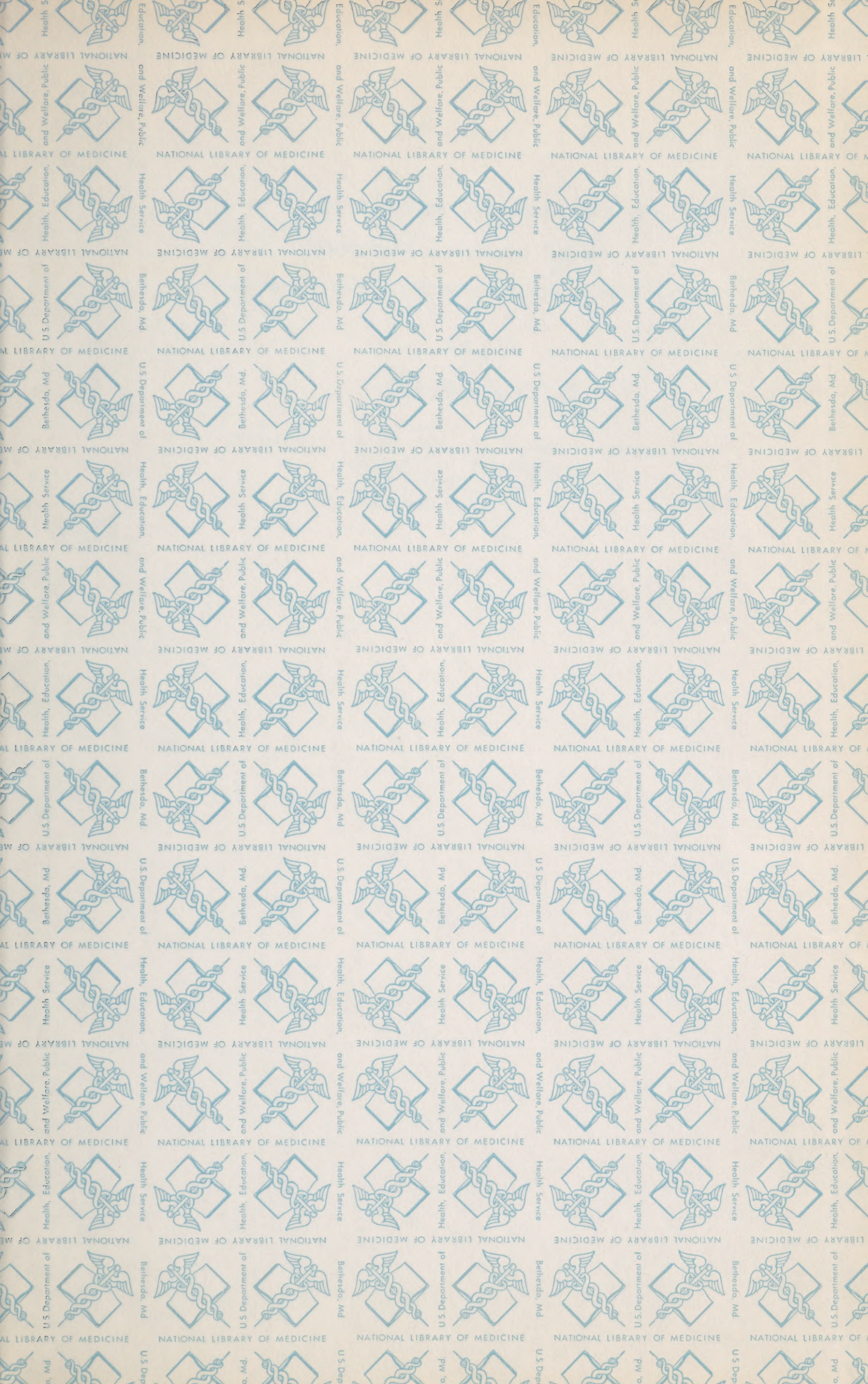
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UNITED STATES MILITARY ACADEMY, West Point

Department of Military Hygiene

Colonel Charles L. Kirkpatrick, M.C., Professor

Lecture I

Anatomy and Physiology

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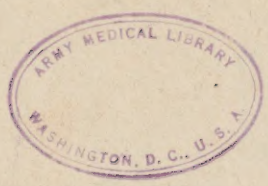

ANATOMY AND PHYSIOLOGY

7 and 8 September 1948

1. Purpose and Scope of Lecture: The normal functions of each organ system will be briefly outlined as the structure is described. Basic anatomy and physiological principles will be illustrated by lantern slides.

Definitions: a. "Anatomy" is the consideration of the various structures of the body and the relationship of its parts.

b. "Physiology" is the science of the functions of the living body.

2. Introduction: The construction of the human body enables it to perform normally under remarkably varied circumstances, and it is equipped to compensate for all the stresses of ordinary life. However, as modern scientists devise means for us to travel faster, farther, and higher, and to move rapidly among hot, dry, or wet environments, a knowledge of the maximum stresses that can be tolerated by the human body becomes increasingly important. Mechanical power and sturdiness of modern air and surface craft cannot solely determine the pattern of engineering advancements. A constantly present and increasingly obvious limiting factor is the ability of the human body to withstand the anticipated operational stresses.

In our times it is well that we understand also the alterations produced in body functions through the effects of tissue irradiation.

3. Units of Body Structure: a. Cell - The structural and functional unit of the body; are microscopic in size.

b. Tissues - Collections of similar cells to perform special functions (nerves, bones, muscles).

c. Organs - Physiological units, composed of two or more tissues to perform highly specialized functions.

d. Body Organ Systems - Formed by groups of organs associated in performing specialized activities. The nine organ systems of the body are:

(1) Skeletal system
(2) Musculature
(3) Circulatory system
(4) Lymph system
(5) Excretory organs (Lungs & Kidneys)
(6) Digestive apparatus
(7) Endocrine glands
(8) Nervous system
(9) Sensory organs

4. Skeletal System: a. Component parts:

(1) Bones - more than 200 form framework of skeleton
(2) Connective tissue
(3) Joints
(4) Cartilages
(5) Bone marrow

b. Normal arrangement and function:

(1) Connective tissue is the most widespread tissue in the body. It forms tendons, forms strong ligaments to reinforce joints, and suspends organs inside body. Connective tissue ligaments of the pelvis can support stress of 880 pounds. It fills in "corners and spaces of the body". The scar formed when a cut finger heals is largely connective tissue. Pads of firm fatty tissue over the buttocks equip us for sitting; under arch of foot they absorb shock on walking; in palm of hand fat pad forms glove to insulate arteries from cold and pressure.

(2) Cartilage and Bone. The purpose of the cartilage covering over the joint surfaces of the bony skeleton is to provide a smooth surface and to act as a shock absorber. The tip of the nose, the external ears and the ends of the ribs are composed of cartilage in order to allow some flexibility. The outer layers of the normal bone are dense and ivory-like. The spongy interior is composed of tiny bony spicules carefully arranged in a pattern to provide the greatest strength. Such structure enables the "shin" bone (tibia) to support a weight of more than 3,000 lbs.

(3) Joints. The four most important types of joints are:

(a) Ball-and-socket joint; in a ball-and-socket joint (shoulder) the bones can be moved in all directions.
(b) Saddle joint (vertebrae) in which the bones move in two directions like a rider in a saddle.
(c) Hinge joint (finger) in which the bones move in one direction.
(d) Rotary joint (elbow) in which the bones move about their longitudinal axis.

The cartilage covering the bony joint surfaces is lubricated by a whitish fluid secreted by the special lining cells of the joint capsule.

(4) Bone marrow. The dark red soft bone marrow occupies the spaces between the fine bony spicules in the interior of large bones. This tissue manufactures the blood cells.

(5) Skeletal Proportion and Arrangement:

(a) Differences in male and female: Man has a narrower thorax, pelvis and abdominal cavity, but a more powerful shoulder girdle than the woman.

(b) Vertebral Column. The backbone is the axis of the skeleton. Bones in its upper part are small and light to provide maximum flexibility while the lower vertebrae are broad and strong to form basic support. The "S" curvature of the backbone enables it to function like a doubly bent spring so that it can absorb shocks and yield to forces that would fracture a straight column.

(c) Thorax. The muscles and 12 ribs of the chest wall form a cage which encloses the lungs and heart.

(d) Pelvis. The pelvic bones form a bowl-shaped container for the abdominal organs. The female pelvis is especially adapted and widened for carrying the pregnant uterus and for delivery of the child.

(e) Extremities. The upper extremity is constructed to be extremely light and flexible while the lower extremity is altered to provide locomotion and support. Although the foot and hands have the same basic structure, the foot differs in that it is actually formed into a tripod, standing on the heel in back and two supporting points in the ball of the foot. This is accomplished by means of a longitudinal and a transverse arch of the bones. Weakening of the ligaments that support these arches or changes of the shape of the bones permits collapse of the bony arch and results in the condition known as "flat feet".

c. Effects of Excessive Stresses on the Skeletal System:

(1) Fractures of Bone: A single clean break through a bone is called a simple fracture. When the bone is shattered into several fragments, it is called a comminuted fracture. If jagged ends of the broken bone stick through the skin the condition is a compound fracture. A partial break through the bony shaft is called a "green stick" fracture.

(2) Sprains: Stretching or tearing of ligaments of joint by wrenching or twisting.

(3) Dislocation. Bones forming joint displaced. There is generally an associated tearing of surrounding capsule.

Muscular System: a. Component parts: (1) Skeletal (voluntary) muscles.
(2) Visceral (involuntary) muscles.
(3) Tendons, tendon sheaths.

b. Arrangement and Function of Muscular System.

(1) Skeletal muscles are under voluntary control and extend between the bones of the skeleton to provide locomotion and support by functioning as first, second or third class levers. Forty to fifty per cent of our weight is made up of voluntary or skeletal muscles.

(2) Tendons. Most muscles end in tough, white, cable-like tendon structures that fasten them to the bones.

(3) Involuntary muscles or visceral muscle forms the walls of most of the body organs, including the blood vessels. The layer of involuntary muscle in the walls of organs enables them to change size and shape. This type of muscle is generally not under our conscious control. It contracts more slowly than skeletal muscle, but it tires less easily and can maintain contraction for longer time. Examples of involuntary muscle action are:

(a) Contracted blood vessels - cause "paling of skin", lack of blood to brain (fainting); if generalized can increase blood pressure. If muscle fibers in blood vessels of skin of face relax more blood there causes "blushing".

(b) Emptying of bladder or intestine (though aided by increased intra-abdominal pressure through contraction of abdominal wall muscles).

(4) Physiology of Muscle Contraction: In many ways the function of our muscles may be likened to the operation of a combustion engine. The fuel supply of the body is in the digestive tract, oxygen is supplied by the lungs and the arteries act as fuel feed-lines with the heart acting as the necessary pump. The combustion (oxidation) in muscles is set off slowly by nerve impulses instead of instantaneously by an electric spark. The carbon dioxide and water resulting from oxidation of fuel are carried away in venous blood in a manner somewhat analogous to exhaust gases from the combustion engine. Contraction of muscles is made possible by a series of complicated chemical reaction within the individual cells and can continue only so long as an adequate supply of food-stuffs and oxygen are brought in by the arteries while the veins simultaneously carry away the waste products.

Fatigue: Nerve fibers from the central nervous system carry impulses which stimulate muscle cells to contract. The energy for contraction is derived from the compounds that the cells have stored in small amounts. The most important is glycogen, a product of the carbohydrates taken in through the digestive system. Fatigue occurs when the muscle cell has used up its stored supply of necessary compounds and accumulated the waste products of the reaction - carbon dioxide, lactic acid, and other compounds of toxic nature. If the brain sends nerve impulses to a "fatigued" muscle, i.e., a muscle still loaded with its toxic products- it cannot contract properly. After the arteries bring in fresh supplies of dissolved nutritive materials and oxygen and the veins carry the toxic waste products away, then fatigue vanishes, the muscle is ready for action again. All cells in a muscle do not ordinarily contract simultaneously. Consequently, light work or exercise can be carried on for long periods of time by means of the nerve impulses calling in groups of "fresh" cells while "fatigued" cells of same muscle are relaxing. The feeling of fatigue that we experience after hard work is based on more than just muscle cells. Nerve cells are fatigued most easily of all, so that the feeling of fatigue is complex and is often associated with monotony, lack of interest, or laziness.

Training. Proper training enables athletes to perform harder work for longer periods because the individual muscles develop stronger and larger fibers. Also, the supply of blood to the muscles is improved. But it is important to realize that continued use of fatigued muscles can be injurious because this will actually cause break-down of cells in the exhausted muscles.

Circulatory System: a. Component Parts

(1) Heart
(2) Arteries
(3) Veins
(4) Blood

b. Structure and Function: Heart: The heart is normally about the size of one's fist and lies between the lungs on top of the diaphragm. It is divided into two parts; the right chambers which receive blood from the veins of the body (dark red) and pump it through the lungs to get rid of the gaseous wastes and to pick up new oxygen. The left chambers receive fresh blood from the lungs (bright red) and pump it out through arteries to supply the tissues with food and oxygen. The heart is a muscular pump made up of involuntary but highly specialized muscles. Valves between the chambers prevent reversal of flow. Diseases that cause scarring and leaking of these valves produce "heart murmurs". The normal pulse rate is about 70-80 per minute.

The Electrocardiogram. The periodic contraction of the heart muscle gives rise to electrical "action" current which can be led off and transferred to a strip of film. Study of such films gives detailed information as to the heart's condition. Examination by electrocardiogram is now part of the routine physical examination for officers beyond a specified age.

Automatic Regulation of Cardiac Tempo. Specialized areas in the vascular system are highly sensitive to chamical stimuli. Accumulation in the blood of acid waste products from fatigued muscles stimulates this area and automatically causes the heart to increase its output so that the blood will more rapidly remove the wastes and carry in fresh oxygen-saturated blood. Increases in blood pressure automatically stimulate other specialized areas causing the heart to decrease its stroke volume, thus lowering the pressure.

Structure of Arteries, Capillaries and Veins. The arteries are muscular tubes, constructed to withstand the pressure of the blood. As arteries continue branching the diameter becomes steadily smaller and the wall thinner. Simultaneously the volume of the vascular bed becomes larger, the pressure lower and the rate of flow extremely slow. Terminally the vessels are 50 times thinner than human hair and the blood cells go through them in single file. The slow passage of blood here provides time for the blood to give up its oxygen and to take up waste products from the tissues.

The tiny capillaries steadily unite to form veins which carry the blood back to the heart. The walls of veins are much thinner than arteries since they have no arterial pressure to withstand. To prevent reversal of flow, the larger veins have valves. Weakening of valves in the legs enables the weight of the column of blood to cause dilatation of the vessels under the skin. ("Varicose veins")

Shock. Shock is produced by "pooling" of the blood in the capillary network. This causes a decrease in the volume of blood available for circulation and a fall in blood pressure. The brain and other organs are not supplied with adequate oxygen by the slowed flow. Shock can be caused by such conditions as penetrating wounds, crushing injuries and poisoning by snake bites or mushrooms.

Blood. The body contains approximately 5.5 quarts of blood which is about 1/2 plasma and 1/2 tiny blood cells. The red blood cells are formed in the bone marrow and are filled with the red pigment hemoglobin which carries the oxygen. Most persons have about five million red blood cells per cubic millimeter.

Clotting of blood occurs if a blood vessel is injured. This is the result of complex process having several phases, and ends with production of fine threads of substance called "fibrin" running all through the blood. These threads enmesh

the blood cells like flies in a spider's web. This tangle spreads among adjacent cells until a "plug" is formed to close off injured site.

Blood Groups and Blood Transfusion. There are four major groups (called O, A, B, and AB). If a patient receives a transfusion of the wrong type, the red blood cells clump together and plug the blood vessels. "Blood Banks" often use group "O" blood since the cells in this group are not agglutinated by the serum of the other groups. Persons with group "O" blood are therefore called "universal donors", since their blood is relatively safe for any person. "O" and "A" are the two most common groups.

Function of blood in combatting inflammation. In addition to the red blood cells, the bone marrow forms a smaller number of white blood cells. These cells provide one of the first lines of body defense against injurious agents or invading bacteria. When a part of the body is wounded and dirt containing bacteria is introduced, the first effect is irritation. This immediately causes an increase of blood to the part. The increased blood stagnates and causes the area to become dark red. The blood plasma carrying many white blood cells exudes through the walls of the tiny blood vessels so that the area becomes swollen. The increased pressure in the swollen region compresses the fine nerve endings, thereby causing the characteristic pain. The numerous white blood cells surround the involved area and advance against the multiplying bacteria. Each white blood cell engulfs numerous bacteria and digests them. Some of the cells are eventually killed by the toxin released from the dying bacteria so that the material called pus consists of both dead and living bacteria, fluid from the blood plasma, and dead and living white blood cells. When a part of the body is acutely inflamed, the bone marrow increases the rate of production of white blood cells. This is the reason that a surgeon who suspects a diagnosis of acute appendicitis will request the laboratory to perform a count of the patient's white blood cells. The more severe the process, the greater the number of white blood cells in the circulating blood.

Effects of Age on the Circulatory System: With increasing age, the arteries become thicker and more brittle; consequently, strenuous exercise or persistent high blood pressure may cause rupture of weakened vessels ("strokes"). The thickened vessels are more easily plugged which causes death of the tissues supplied by the vessels (sudden death from heart attacks).

Lymphatic System; Tissue Fluid: a. Component parts:

(1) Lymph vessels and spaces
(2) Lymph "glands"
(3) Tissue fluid.

b. Function and Arrangement. A small amount of thin clear fluid oozes from the walls of the smallest blood vessels and bathes all of the cells of the body. It then collects into special tiny tubes called "lymph vessels" which unite to form larger lymph trunk lines that generally run along veins and eventually empty back into the blood. A thin film of such fluid keeps the surfaces of all organs moist. The brain and spinal cord are bathed in such a clear fluid. The lymph fluid is filtered at certain points in the body by small nodules of specialized tissue called "lymph glands". These glands remove any foreign material that the fluid may have washed from between the cells.

The Excretory Organs: a. Component Parts:

(1) Respiratory system (air passages, lungs, diaphragm)
(2) The urinary organs (kidneys, ureters, bladder)

b. Structure and Function of the Respiratory System:

(1) The Respiratory Gases. At ordinary altitudes air contains approximately 79% nitrogen, 20% oxygen, and 1% rarer gases. The oxygen necessary to maintain vital tissue metabolism is taken directly from the air in the lungs by the red pigment of the red blood cells.

(2) The Nose. The scroll-shaped overhanging structures in the wall of the nose increase its surface in a manner similar to the leaves of a radiator. This surface serves to moisten and to warm the incoming air. Dust particles are filtered by the hairs in the front of the nose.

(3) The Lungs. The inhaled air is conveyed to the lungs through the "windpipe" (trachea) a flexible tube with embedded cartilage rings to prevent collapse. Food and irritating substances cannot enter the windpipe because of the flap-like cap called the epiglottis which covers the top of the tube and snaps shut automatically at the slightest touch of solid particles or irritating bases.

Because of this automatic mechanism, a man under water may develop a spasm-like closure of this cap and drown (suffocate) under the water without any fluid entering the lungs.

(4) The Diaphragm. The diaphragm is a thin muscular layer that forms a dome under each lung and separates the chest cavities from the abdomen. Inhalation is accomplished by contracting muscles that lower the diaphragm and pull the ribs outward. This tends to create a partial vacuum in the chest since the lungs are enclosed in an air-tight space. Consequently, atmospheric pressure forces air into all of the tiny air sacs of the lungs. Air is forced out of the lungs by elevating the diaphragm and inward movement of the ribs.

(5) Vocal Apparatus. The "voice box" or larynx is a cartilage reinforced tube in the throat on top of the windpipe (trachea). In this box two delicate folds of the lining membrane are stretched in a "V-shaped" manner to form the vocal cords. Small muscles alter the tension of these folds to give different voice notes as the vocal cords vibrate in the passing stream of air.

Effects of Excessive Stress on the Respiratory System:

(1) Noxious gases. Certain war and industrial gases cause severe irritation to the lining of the respiratory system and may cause a spasm of the epiglottis with resultant suffocation. Other gases cause an extreme weeping of fluid from the lining of the lungs so that the air sacs are filled with fluid. Such a condition causes a person to "drown" in his own body fluid.

(2) Stress of High Altitudes. "Altitude sickness" occurs at high altitudes because the lungs are not able to get the required amount of oxygen from the inhaled air.

NOTE:

Altitude	Pressure in mm. of mercury	Temp (°C.)	Equiv. Oxygen
0	760.0	15	20.93
10,000	522.6	-5	14.39
20,000	349.1	-25	9.61
40,000	140.7	-55	3.89

Although symptoms may develop above 10,000 feet in some individuals, the "disturbance stage" is generally between 15,000 and 20,000 feet.

The "critical" stage generally occurs between 20-23,000 feet.

(3) Penetrating wounds are especially dangerous because they allow air to rush into the normally "air-tight" chest cavity so that movements of the chest wall and diaphragm no longer cause the lungs to expand and bring in the necessary oxygen.

Urinary Organs: (1) Kidney. The two kidneys are at the back of the abdominal cavity, one on each side of the spinal column. Each kidney consists of about a million tiny similar units which form the urine by filtering the blood passing through the kidneys.

(2) Ureters. These are cylindrical muscular tubes which carry the urine from the kidneys along the back of the abdominal cavity into the bladder.

(3) Bladder. The bladder is a hollow muscular organ in the pelvis, lying in front of the rectum. The desire to urinate is automatically produced as it fills with urine by the tension caused on the nerves in its wall.

(4) Urethra. This is the muscular tube that carries urine from the bladder to the exterior.

NOTE: The differences in male and female sex and urinary organs will be shown on lantern slides.

The Digestive System and Metabolism:

a. Component Parts:

(1) Mouth and esophagus
(2) Stomach and intestines
(3) Liver and pancreas

b. Body Metabolism; Nutrition; Classes of Foodstuffs:

(1) Classes of Foodstuffs:

(a) Protein
(b) Fats
(c) Carbohydrates
(d) Minerals and Vitamins.

(2) Normal caloric requirements of the body:

(a) Absolute rest - 1,680 cal.
(b) Bed rest - 1,890 cal.
(c) At ease - 2,520 cal.
(d) Moderate work - 3,360 cal.
(e) Heavy work - 6,720 cal.

(3) The carbohydrate or "energy" foods provide most of our calories. (Bread, potatoes, sugar.) For each gram of carbohydrates eaten a person normally derives about 4 calories. Protein foods (meats, cheese, milk, eggs) also provide 4 calories for each gram, but protein foods are also vitally important because the protein portion of the diet is partly used as building material for new cells in the body. Fatty foods provide more than twice as many calories per gram as do carbohydrates and proteins.

Function and Arrangement of Digestive Organs:

(1) The sensations of hunger and thirst are automatically established by nerve reflexes that report to the brain the status of the intestinal contents and the degree of concentration of the blood.

(2) Mouth Cavity. In addition to grinding action of the teeth and tongue, saliva is added to initiate the digestive process. The specialized salivary glands are:

Paratoid (in front of ear - gland involved in mumps - for large quantities of watery saliva, as when eating bread)
Sublingual (under tongue)
Submaxillary (under lower jaw) produce thick mucous saliva, as when drinking milk.

(3) Esophagus. The esophagus is a muscular tube that carries the swallowed food down into the stomach. Once the bolus of food enters the esophagus, it is automatically forced through by the muscles of the wall.

(4) Stomach. The wall of the stomach is made up largely of powerful muscles of involuntary type which enable it to thoroughly churn the food and mix in the digestive juices. Rings of muscle at its entrance and exit regulate the flow. Specialized cells in the lining of the stomach secrete the ferments which continue the digestion of the food that was started by the saliva ferment. Digestion also depends considerably on the hydrochloric acid formed by other special cells in the stomach lining. The high concentration of this acid aids in killing any bacteria that might have been swallowed. The stomach ferments (enzymes) are especially adapted for protein and carbohydrate foods; consequently, fatty foods are likely to stay in the stomach for longer periods.

(5) Small Intestine. The small intestine is a thin-walled muscular tube generally measuring slightly more than 20 feet which is coiled about in the abdominal cavity and passes the food from the stomach into the colon. Digestion is continued in the small intestines by the digestive juices formed in the liver, pancreas, and specialized cells in the intestinal lining. The ingested food is made semisolid by the 5-10 quarts of these digestive juices which are poured into the intestine each day. This mixture is passed through the intestines by rhythmic contractions of the involuntary muscles in its wall which provide a "milking" or "squeezing" action. The lining surface of the intestine is tremendously increased by thousands of tiny folds in its inner layer. When the food-stuffs are broken down from complex to exceedingly simple molecular structures the useful molecules are absorbed through the intestinal wall and pass into the circulating blood where they are carried to the various body tissues for use.

(6) Large Intestine. The large intestine is a horse-shoe shaped segment of the bowel beginning on the lower right side and passing upward, across and down the left side of the abdomen to the rectum and anus. When the thin fluid mixture enters the colon or large intestine, most of the water is absorbed back into the blood stream, thus producing the formed or semisolid feces. Diarrhea, the passing of loose fluid stools, is caused by premature evacuation - that is before the proper amount of water has been absorbed by the colon back into the body. Constipation occurs when the colon retains its contents too long, thus accumulating excessive fecal masses which become very dry and hard because the lining of the colon absorbs excessive amounts of moisture.

(7) Liver. The liver lies immediately under the right dome of the diaphragm and forms the bile that flows down a narrow tube to the first part of the intestines. "Yellow jaundice" may occur if this tube is obstructed by cancer or a gall stone so that the greenish-yellow bile builds up enough pressure to be filtered backward into the blood that flows through the liver. The liver also serves to manufacture most of the body proteins from the simple molecules absorbed by the intestines, and acting as a blood filled sponge it filters all blood coming from the intestines before it reaches the heart. It is thus able to render harmless many of the toxic substances that we eat.

(8) Pancreas. The pancreas is constructed very much like a large salivary gland and forms the most active digestive ferment. Small islands of specialized cells form a substance called insulin which passes directly into the blood stream. The lack of an adequate supply of insulin causes diabetes.

Effects of Excessive Stresses on Intestinal System:

(1) Nervous tension causes poor digestion because the muscular walls of the stomach and intestines become spastic and fail to keep the food mixture moving along normally. It is now well known that prolonged emotional stress predisposes some men to development of stomach ulcers.

(2) Improper bowel habits or an improper diet may cause chronic constipation. When the colon becomes widened due to the packed fecal masses, the veins in the wall are compressed. Dilatation of the veins below the compressed site produces hemorrhoids.

The Endocrine Glands: The central nervous system sends messages to every part of the body over a network of nerve fibers. Another method of transmitting messages from one part of the body to another is by chemical messengers known as

UNITED STATES MILITARY ACADEMY, West Point.

Department of Military Hygiene

Colonel Charles L. Kirkpatrick, M.C., Professor

Lecture II

Introduction to Military Medicine

Including Medical Department Responsibilities

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INTRODUCTION TO MILITARY MEDICINE
INCLUDING MEDICAL DEPARTMENT RESPONSIBILITIES

9 and 10 September 1948

INTRODUCTION:

The conduct of modern war, which means "total" war, calls into play every art and science known to man; therefore, it seems logical that success in war can be expected by the nation which uses all available knowledge and all of its means to the best advantage. Military medicine is one of those means and forms an integral part of our modern military machine both in peace and war.

The medical man is an essential part of every military team, be it staff or combat group. He must know much about the art of combat, tactics and logistics, in addition to being highly qualified in his own special medical skill. Officers of our department receive military instruction throughout their careers. Numbers of us have in the past and currently are participating as students in all of the armed service school courses. The outstanding record of military medicine achieved in World War II was established in large part through the complete confidence placed in our medical leaders by military commanders who had been in many cases fellow students with them previously in classes at our service schools and colleges.

My purpose is to acquaint you with the importance of military medicine to the national effort, and the part it will play in your duties as line officers. Without some knowledge of the "what", "why", and "how" of military medicine, and a thorough appreciation of your part in achieving our common military mission, you cannot expect, nor will you achieve full success as military commanders.

There is no intent, nor is there any need to train you as physicians in order that you may discharge your responsibilities fully as commanders; however, the more you know in the medical field the more readily will you arrive at sound decisions in using your medical means in any situation. The organization of our army provides commanders at all levels with competent medical advisers for any contingencies that may arise. It is the use that is made of medical advice which determines one's capacity to efficiently discharge his responsibilities as a commander.

DEFINITION:

Military medicine may be defined as that specialty which encompasses all features of the art and science of medicine involved in the prevention of disease and injury and in the treatment of sick and injured militarized personnel.

Medicine, like many of its sister professions, has developed through scientific advances a complexity and breadth of scope that is beyond the capacity of any single mind to master; hence, it has been inevitable that specialization in the branches of the profession should develop.

There are many branches of medicine that have particular military significance. Preventive medicine, aviation medicine, atomic medicine, nutrition, and surgery are but a few. The training given the average medical student is deficient and ofttimes totally lacking in many of those fields. The practice of medicine in a civilian community is far different in scope from that necessary with troops at war. The civilian practitioner is not faced with the problem of providing and controlling equipment for the transportation and hospitalization of his patients. Neither is he interested in climatic conditions and incidences of diseases in areas other than his own community. In contrast, the military surgeon is vitally concerned in these matters and must be equipped to provide complete medical service in any part of the globe under the most adverse conditions. The civilian doctor works as an individual and is rarely involved or hampered by having to coordinate his actions with other widely different activities. The military surgeon is always under the handicap of having to fit his activities into team play which demands emphasis first, last and always on keeping the peace or winning a war.

Military medicine is a specialty requiring in addition to the usual professional training possessed by the average practitioner of medicine and surgery, formal education - in military organization - the employment of military forces in war - special training in preventive medicine - public health, and the military aspects of war medicine and surgery. Military experience is also necessary to develop and round out the individual's capacity to meet large scale medical emergencies in peace or war.

The broad scope of military medicine has resulted in the development of specialties within the field; such as, military aviation medicine, military industrial medicine, atomic medicine, and so forth.

A realization of the qualifications necessary to practice the specialty of military medicine should be enough to dispel the common misconception that a physician called into service from civil life is fully qualified to perform all the duties of an army medical officer. Without special military training, his usefulness is restricted to the purely professional duties in the service involving individuals which are similar to civilian practice.

HISTORY:

While it is true that military forces have had some form of medical aid since the first of recorded history, it is not until the latter part of the Nineteenth Century when science began to replace empiricism in medicine that it emerged in civilian life as well as in the army from a comfort-producing process into a planned scientific attempt to conserve manpower. When military efficiency became the motivating factor of military medicine, rapid strides were made and the specialty we know today attained its adulthood.

It is generally agreed that the development of military medicine paralleled the advances made in civilian medicine throughout the course of history; however, there is no doubt that in the field of preventive medicine that the military has consistently made the initial development and the most progress. This is understandable if we consider the opportunity for controlled investigations in the field of preventive medicine that military masses present. It was and still is the impelling challenge to the medical profession to prevent disease in and to maintain the fighting efficiency of our military forces, coupled with the opportunity for wide scale investigation which the service affords that has made our medical officers foremost in the field of preventive medicine.

Ample proof of the gigantic advances made in military medicine in its effort to achieve its ultimate goal is patent in the results recorded in World War II. For the first time in history the manpower losses incurred by our forces from all the various and sundry man-made weapons designed for human destruction were greater than those occasioned by the hitherto unconquered and invisible enemy — disease. Those records were established definitely as a result of the advances of medical science and not as some may be led to think by the greater efficiency of modern weapons.

In reviewing military history, it is most enlightening to trace the rather rugged route the military medical man has traveled. The visible results of human wreckage suffered in man to man combat eventually produced the first doubt in the minds of the ancients that all human suffering stemmed from incurring the displeasure of the gods. Curiosity resulted and brought about the urge to investigate the structure of the human and its scheme of functioning. That was the beginning of true medical science. As a result of this knowledge, physical means to alleviate human suffering and to aid in body repair were developed and replaced the magical maneuvers of the time-honored mystic. Thought also replaced faith in the field of sanitation and we find that Moses in his famous laws prescribed practical measures that did prevent transmission of disease. He truly deserves the honor of being named the father of preventive medicine just as Hippocrates has been honored as the father of medicine.

Starting with this era we note the constant close association of the medical man with the combat soldier which has endured to the present. The Byzantine Mauritius of the Sixth Century was the first leader to provide specific medical formations for the care of the combat wounded. Later Leo, another Byzantine, recorded in his famous work TACTICS the provisions for surgeons and litter bearers in his armies. He expressed for the first time, in writing at least, the importance the care of the wounded has in establishing and maintaining battle morale of troops.

Developments in military medicine continued slowly but steadily throughout the period of the Crusades as is evidenced by the work of the Knights Hospitaliers of St. John of Jerusalem who cared for the wounded on the battlefields, and first established military hospitals and medical schools.

Then came the Dark Ages with the decadence of all things, including medical. Cast aside were the lessons of the past and the teachings of the ancients. The armored knight of the day because of his protecting garb shunned medical aid and we find the surgeon of this era relegated in the military to the dubious distinction of being a combination barber and surgeon. Ofttimes the executioner held sole sway in medical fields, probably because of his supposed knowledge gained in his intimate association with human anatomy in performing his tasks. It is significant to note in this period that in consonance with the strict class distinction of the times the wealthy nobles retained personal physicians for their own welfare during combat; while the common soldier, befitting his state of serfdom, received no medical care whatsoever.

With the advent of gunpowder and the passing of the armored knight the necessity for military medical aid to the soldier again became apparent, but so long had the welfare of the common soldier been forgotten in the minds of military leaders that progress was slow and we find that nondescript camp followers did most of the so-called medical aid in the early stages of that era.

The Sixteenth Century developed in the person of Ambroise Pare, the noted French Surgeon, the first military surgeon of modern time. This distinguished humanitarian and surgeon gained his first impressions of the battlefield and its human wreckage at Turin in 1537. He revolutionized the treatment of battle wounds by eliminating the pouring in of boiling oils and removed from the practice of surgery many of the procedures which were of no avail medically and actually were but added torture of undescribable nature.

The first provisions for transporting wounded on the battlefield by wheeled vehicles were made during the Thirty Years War when that great military genius Gustavus Adolphus provided separate medical arrangements for the care of his wounded as well as those of his enemies who fell into his hands.

Louis XIV of France and Frederick the Great set landmarks in the progress of military medicine. They provided medical formations for their armies and in addition, personally saw to it that their orders regarding the care of the sick and wounded were executed. During this era we note the rediscovery of the truths which were well known to the ancients; that the thing that made men willing to fight to the death was not just the simple urge to prove the law of the survival of the fittest, but a rather complex mechanism which included surety of medical aid which in the event of injury would alleviate suffering and provide a better chance for self-preservation. Progress in military medicine was slow, principally because many of the imperious leaders of the time still insisted that non-combat troops of any category were but impediments to their so-called combat forces.

Our American Revolution was not long in being — in fact, it was at Bunker Hill, before the need for medical service was voiced. George Washington in 1775 recommended the creation of a medical service to the Provisional Congress of Massachusetts. Although its organization was most meager, it functioned after a fashion with a regimental medical service and a crude form of hospitalization. It lacked provisions for any centralized control over the authorized medical personnel and facilities, and we find the skill of the surgeons being wasted through poor organization. Betterment in that respect was made later, when the Congress appointed Dr. Benjamin Rush of Boston as the Director General and Chief Physician of the army. Little was accomplished in sound medical

organization requirements, however, as evidenced by the Continental Army's request in 1776 for women to care for the wounded. The distinction made between physicians, surgeons and apothecaries of that day worked against sound organization and medical team play. In 1777 Dr. Shippen, who had been designated Director General of the Military Hospitals of the Continental Army, drew plans for "flying ambulances" designed to bring the physician to the wounded on the battlefield. This may not have been original on his part as Napoleon's chief physician, Barron Larrey, is also credited with the idea in addition to many others, especially in improving war surgery. Larrey was well trained in medical military matters, serving fifty-three (53) years in the Army. He was wounded three times and participated in sixty battles, and over four hundred military engagements. Napoleon did not seem to learn much regarding the value of caring for the sick and wounded - sanitation had no appeal to him -- he did, however, approve of flying ambulances to boost the morale of his troops.

In 1780 our first army regulations were written and published by Major General de Stueben. They contained a chapter relating to the care and treatment of the sick and wounded.

The failure of Napoleon's Invasion of Russia in 1812 can be traced to the epidemic of typhus fever which descimated the ranks of his army. This was, undoubtedly, a return of the Black Death of the Middle Ages. The Russian people, having been exposed to typhus fever previously, had some immunity and consequently their army did not suffer the same fate as the French. This is an excellent example of controllable disease being the dominant factor in the outcome of a military campaign.

Between 1784 and 1812 the strength of our army varied. In 1784 the Medical Department consisted of one surgeon and four surgeons' mates. There are few records of the army covering those penurious days and we are sure there was no central medical organization -- no military hospitals -- no rules governing sanitation. Our ill fed, ill paid, beggarly soldiers evidently had to secure their own medical attention from civilian sources as best they could.

The war of 1812 was noted for its lack of funds available for medical purposes, although surgeons did accompany the troops in the campaigns. It demonstrated once again that the care of the sick was a greater burden to the army than that of the care of the wounded. Contagious diseases and wound infections caused more deaths than enemy action. It brought the first observation that hospitals that were kept clean and well ventilated had the least incidence of disease in their patients.

In the 1818 reorganization of the army the Medical Department was established as a staff section. Dr. Joseph Lovell was appointed the first Surgeon General of the army. This epochal step provided the keystone of an organization from which evolved all progress to date made in American military medicine.

In the Mexican War, Surgeon General Thomas Lawson who had commanded a regiment in the Seminole War accompanied General Winfield Scott in the field. One-third of Scott's command contracted yellow fever at Vera Cruz after he had discarded the advice to avoid stopping in the city. As a result that disease was introduced into The United States.

Progress was being made gradually as is evidenced by the fact that prior to the Civil War Congress had authorized definite army rank for physicians. It had also provided for hospital stewards and the position of Brigade Surgeon. Female nurses were also authorized for the army at the daily pay of $.50.

The army numbered about 15,000 sorely neglected men of all ranks when the Civil War broke out. It was ill-trained and scattered in small groups over the country and obviously was unprepared for the task at hand. Two hundred and twenty-five thousand soldiers died from disease and 110,000 from wounds in the four years of the Civil War on the Union side alone. Out of this sordid demonstration of medical inefficiency emerged one of the all-time greats of military medicine -- Surgeon Jonathan Letterman. He produced a sound and definite system for the evacuation and hospitalization of the sick and wounded which has withstood

the test of all of our wars since his day. His scheme provided first aid stations on the battlefield, ambulances, field hospitals, and base hospitals, all forged into a chain of medical service which is used today, not only in our army, but in all others.

The Franco-Prussian War demonstrated on the German side the value of a good medical service which was based on Letterman's plan.

In 1887 Congress authorized a hospital corps of enlisted men which allowed for the first time the formation of all Medical Department units. In 1891 Surgeon General Sutherland recorded evident faults in the construction, housing, heating, ventilation, and drainage then existing in army facilities. Incidentally, it was without avail. It did indicate, however, that sanitation as a weapon for disease prevention was urging itself forward again as an important element in promoting the efficiency of our troops.

The short Spanish-American War demonstrated once again the well-established truth that disease was the greatest single man-killing factor in troops at war. In our army of 235,000, 3500 died from typhoid fever alone, while only 266 were killed in action. Public reaction to this event brought about the demand for concerted medical effort to study means for the control of typhoid fever. A board of army medical officers found that the disease was spread not only by water as had been proven previously, but by personal contact and through the medium of the fly as well. This discovery led to the development of sanitary measures to prevent its spread in the future.

In 1900 Major Walter Reed's Board of Medical Officers discovered that yellow fever, then a ravaging scourge in the tropics, was transmitted by a particular mosquito. In 1903 Major Gorgas reported that with that knowledge he had been able to stamp out the disease in Cuba. This was to gain him fame later in the Panama Canal Zone when he successfully accomplished for our engineers working conditions that permitted the construction of the Canal. The French engineers who had built the Suez Canal and were well-qualified technically were defeated in their attempts in Panama because of their enormous personnel losses from yellow fever. This achievement did more to open the eyes of America and the world to the importance of preventive medicine than any other single event in modern times. The health, economics, and commerce of the globe had been affected by the application of simple sanitary measures to prevent disease.

Overshadowed at this time by the work of Gorgas was that of Major Darnall of our Corps who had developed a process for purification of water by use of liquid chlorine. This method is still in use throughout the civilized world and has probably saved more lives than any other single discovery in preventive medicine.

Transformation in medicine to a scientific basis was greatly accelerated by the dawn of the Twentieth Century.

The era of the prophylactic use of vaccines began with Russell's work on typhoid fever in our army. This led to an endless search for other agents to secure immunity to disease.

In 1917 when war came upon us we had for the first time in our history the knowledge and implements for a scientific approach to the application of military medicine on a large scale. A comparison of the results achieved by military medicine in World War I with those of our Civil War is mute testimony of the great progress made in the intervening fifty-five years. However, we still had 63,000 deaths from disease in contrast to 51,000 deaths from battle casualties in World War I. We were most unfortunate in 1917 and 1918 in suffering a pandemic of virulent influenza which produced 25,000 of the military disease deaths. Smallpox, typhoid fever and tetanus, all potent killers of military masses in the past, were effectively brought under control in this war. It was quite evident that even with the great advances made in modern surgical technique of that day, which saved many lives and salvaged many more, preventing disease in our fighting men was still the major problem of military medicine. The war also gave the clinic system as used in the army to civil life - the first

demonstration that team play in medicine is the most efficient.

With the advent of aviation, new medical problems were presented in connection with the physiological efficiency of the airman. Since 1918, when the first Board of Medical Officers began research in this field, steady progress has been made and is continuing abreast of the technical advances made in aircraft permitting fantastic speed and altitude performances. Today aviation medicine has become a specialty because of its wide scope and complexity.

The post World War I period produced incontrovertible proof to the public as well as to our military leaders that military medical facilities had to be adopted as a major element of any war-making machine of the future, and that adequate provisions for them, regardless of cost, were imperative if we were to succeed in our periodic struggles for national independence.

The achievements in military medicine in World War II need but little mention here, except to impress you with the cost of that effort in manpower demands. It took 47,000 physicians, 57,000 nurses and approximately 550,000 enlisted men and other ranks to do the job. The disease rate in World War II dropped to .6 men per thousand per year from 16.5 men per thousand per year in World War I. This was accomplished in spite of the fact that over sixty percent of our army was overseas and subjected to every conceivable disease hazard and in areas ranging from the arctic to the tropics. There were no deaths from typhoid fever, typhus fever, or tetanus in immunized personnel.

Our victory over disease was aided materially by the introduction of DDT, the sulfonamides and penicillin. Our military experience and developments of these great boons to civilization established them as commonplace drugs in present day medicine.

We can be sure that the public will demand medical standards of this modern era in mobilizations of the future so we may as well face the hard facts that from now on adequate facilities for the practice of military medicine in our army must be provided regardless of their cost in manpower. To fail to do so ignores the lessons of the past and to discard the progress which military medicin has made in our army in the past ninety years.

We can sum up the lessons of this tour through the military medical history of the ages by saying that medical service to armies has developed from acceptance of the following considerations:

That it is necessary in order to get the loyal support of combat troops;
That it is a legal obligation of the State to each individual who serves the State in war;
That humanitarianism demands it;
That it reduces the economic burden of supporting the maimed by minimizing disabilities;
That it assures military efficiency.

MISSION:

The mission of the Medical Department is laid down in army regulations. It is simple — the conservation of manpower — the preservation of the strength of the military forces.

To accomplish that mission an organization has been established within the army, which has authority to process all of the manifold procedures necessary to govern the complex and widespread field of military medicine. Lest there be any questions in your minds that I prefer or am even suggesting an independent status in the army for the Medical Department separate from overall military command, let me emphasize our absolute belief and acceptance of the soundness of the system of command which from the beginning of our military history has placed full responsibility in the commander alone for all that transpires.

RESPONSIBILITIES OF THE MEDICAL DEPARTMENT:

Our mission can be broken down into three major tasks. First, that of selecting only the physically fit for service. Second, that of preventing illness and injury in service personnel. Third, that of restoring those who become sick or injured speedily to health. In the execution of these tasks certain definite responsibilities and duties have been charged by regulations to the Medical Department. These are:

SLIDE — PHYSICAL EXAMINATION. This includes not only the initial physical examination given each applicant for admission to all components of the Army of The United States to determine his acceptability, but also the periodic examinations all of us must undergo to establish our continuing physical fitness for military service. World War II experience resulted in the adoption of the Physical Profile Service System in the army, which is a ready index to those in assignment positions. However, much more research is needed in this field to develop yardsticks to assess mental stamina, industry, loyalty, devotion to duty, and courage in addition to physical fitness.

SLIDE — PRESERVATION OF HEALTH. This involves the prevention of disease and injury in service personnel through the application of modern military medicine and includes the control of public health measures in peoples of occupied territory.

SLIDE — CARE OF THE SICK AND WOUNDED. This involves rendering medical, surgical, and dental care to the sick and wounded to restore those not permanently disabled to duty as speedily as possible while promptly removing those permanently disabled from the service. It includes the most important phase of reconditioning which is now a specialty of medicine.

SLIDE — DISPOSITION OF THE SICK AND WOUNDED. This entails the establishment and operation of a sorting process which insures the retention of the effectives within their command while speedily removing noneffectives from a command, who by their presence are a burden to the fighting forces.

SLIDE — TRANSPORTATION OF THE SICK AND WOUNDED. This entails the provision of personnel and equipment sufficient to transport the sick and wounded once they have come under Medical Department control. Its requirements encompass the provisions for all methods of transportation on land, sea, and in the air.

SLIDE — ADMINISTRATION OF MEDICAL FACILITIES. This includes the functions of command, administration, and operation of all medical units and facilities established for the care, transportation, and treatment of sick and wounded personnel and animals, and in addition, those facilities established for the training of Medical Department personnel and units. Prior to World War I the training of medical units was frowned upon by the line. They could not understand why they should be trained as such during peace because no one was sick or wounded, overlooking the fact that they were training the infantry and artillery to shoot - at a time when there was no one to shoot. It also includes supervision of the construction, leasing, and maintenance of all medical facilities in addition to the preparation of estimates for Medical Department appropriations and the control of expenditures therefrom.

SLIDE — REPORTS AND RECORDS. This involves the preparation and disposition of all records, reports, including photographic and cinematographic productions pertaining to the activities of the Medical Department. It also includes the compilation of data for vital statistics, and the preparation of the annual report of The Surgeon General to the Secretary of the Army.

SLIDE — MEDICAL PERSONNEL. This involves the selection, appointment, classification, assignment, and training of all Medical Department personnel, active and reserve.

SLIDE — VETERINARY SERVICE. This includes not only the initial examination and selection, but also the prevention of disease in and the professional care of sick and injured army animals. Further, it includes the inspection for purchase and issue of meats, meat foods and dairy products required by the army.

SLIDE — MEDICAL SUPPLY. This includes the production or procurement, the storage, issue and maintenance of all medical supplies, and equipment for the army.

SLIDE — RESEARCH. This includes not only the research, experimentation and development involved in the production and use of Medical Department supplies and equipment, but research also in the various fields of medicine that pertain to all possible activities of the medical service under all possible conditions of climate and warfare. There are still many unsolved problems of the last war in addition to those anticipated for the future. The great lesson learned is the vital necessity for research and development in peacetime to prevent the hard way of learning our deficiencies on the battlefield.

SLIDE — PLANNING. This involves the preparation and maintenance of plans for the mobilization and use of Medical Department personnel and materiel for war or any major emergency.

SLIDE — SERVICE TO THE AIR FORCES. Present policy of the National Defense establishment prescribes that the Medical Department of the Army continue to provide all medical service to the now separate Air Forces. The medical problems peculiar to aviation have from the beginning necessitated the services of specially trained medical officers who have been attached to the Air Forces for duty.

THE FUTURE:

What does the atomic era portend for military medicine? While there may be some diversion of opinion concerning the strategic or tactical use of atomic missiles and power, there is one fact that is established beyond doubt; that being its effectiveness as a casualty producer. This fact is just as important for you to realize as it is for us in the medical profession. The human carnage produced by the new man killers, while only slightly different in character from that produced by high explosive missiles of the past, exceeds in quantity anything ever previously experienced by our army. Not only is it the magnitude of the numbers of these casualties that presents a collossal task for the medical service, but just as important is the fact that they are produced in such large numbers instantaneously. This demands that we provide in advance of any attack the necessary medical wherewithal, including personnel and facilities, to adequately cope with any eventuality at home or in military ventures overseas. There is doubt in many minds whether our people in attacks on the homeland, sure to come in future total war, will support to the bitter end any military effort involving their lives and those of their sons without evident provision for medical and other relief for the homeless, the suffering wounded, and the maimed. The test of our national moral fibre to withstand the impact of atomic warfare at home, when and if it comes, may well result in early and complete defeat of our national effort if there is a lack of adequate medical service. The effects of mass war psychology must be anticipated. This indicates that educational measures be developed now and set in motion to counteract mass hysteria reactions. If I would leave with you but one thought today, it is that one — as it spells to me the whole future of our country.

To further complicate the medical future, the advances made in biological warfare make it possible that that bothersome agency of pestilence may be added to or used separately from atomic weapon attacks on the homeland.

In time of war one of the most distressing problems confronting commanders is the one which deals with the mental health and motivation of their commands. Losses of trained combat troops from conditions brought about by so-called "anxiety states" on the battlefield were staggering in World War II, and consequently were often a determining factor in the outcome of battle. Most of

these cases were intimately connected with the lack of proper leadership. Much has been learned since 1942 about the prevention and treatment of these reactions to military demands which you will hear about in detail later in this series of talks.

CONCLUSIONS:

The execution of many of the procedures concerned in the accomplishment of the mission of the Medical Department, especially in the field of preventive medicine, is in your hands as line officers. Without proper understanding of your responsibilities in this field, rigid attention to details of execution, and above all, the proper attitude and approach to these problems, you cannot get the full value of modern military medicine so essential to success in modern warfare.

As I see it, there are four things you as future commanders must learn in order to fulfill your part in the practice of military medicine in the army. First, you must have some knowledge of preventive medicine and the machinery by which it works in the army. You must understand its vital importance to your success. Second, you must develop a sound discipline, devoid of personal animosities, pet beliefs and schemes, to enforce at all cost the command details inherent in the processes of securing health in troops. Third, you must develop full confidence in the ability of your medical personnel to perform their special technical skills. Fourth, you must develop the qualities of leadership so essential, as proved by experience, to prevent the mental casualties in combat troops engaged in war. These constitute responsibilities in the practice of preventive medicine in the army which are outside the realm of the Medical Department.

You may rest assured that your Medical Department is cognizant of the possibilities of future total war. Already we have made enough progress in our research to dispel the development of hysteria and fear in our people of radio-activity casualties coincident with atomic fission. They constitute but one-fifth of the total cases, and patently form but a small part of the medical problem. We have established our requirements to cope medically with the new powers and threats of modern total war, and we feel confident that given the means, proper authority, and your support we can accomplish our mission just as effectively as we did in World War II.

UNITED STATES MILITARY ACADEMY, West Point

Department of Military Hygiene

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Lectures III and IV

Strategic and Tactical Influence of Disease in Modern War

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STRATEGIC AND TACTICAL INFLUENCE OF DISEASE
IN MODERN WAR

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The memory of men going ashore on a Normandy beach or approaching a Pacific island - American soldiers going into action - is still too vivid to leave any doubt as to where wars are finally won or lost. As certain as that may be, modern warfare is such that influences other than the courage of the men concerned or the quality of their leadership in combat, act strongly in determining the result. Disease and injury, and the quality and kind of medical care, constitute 1 such factor.

No attempt is made here to determine the relative importance of medicine and the other necessary services supplied to combat forces. It is likewise left to others - to the professional soldier, the statesman or the historian - to state the place of medical matters among activities that involve the whole of a population at war; the production of war materials, the management of economic stresses, and the maintenance of that fine balance of political and social interests within a nation and in respect to its allies. Few medical officers would attempt either evaluation; certainly not a civilian physician-soldier whose service was limited to the army in the field. The present analysis is confined to some of the ways that medical affairs enter into the management of military operations and the extent to which they influence the result. Since the experience and the data are wholly of army origin, the consideration of strategic and tactical influences of disease will relate only to that part of military activities. Most of the examples cited are from the European Theater of Operations of World War II.

RESPONSIBILITY FOR HEALTH. That the maintenance of the health of troops is a function of command is an accepted part of military theory and so prescribed in the regulations of the United States Army. Time was when this meant principally an adequate attention to the care of the sick and wounded. The past half century has brought about a greatly broadened interpretation of this obligation, to the extent that the prevention of disease now ranks as a coordinate activity.

While modern military medical practice has 2 principal objectives, those of medical care and preventive medicine, the organization for provision of these services is by no means to be interpreted as consisting of 2 parts. These primary interests overlap, and the successful accomplishment of both objectives depends upon the extent to which they are integrated into a single practice, which recognizes no sharp distinction between what is preventive and what is curative medicine.

Medical care in military practice has come to involve much more than the simple issue of death or recovery. Increasing attention is directed to the development of improved method for the prevention of physical defect after disease or injury, and for limitation of the period of disability. Both features act toward the welfare of the individual, and from the viewpoint of military operations are important considerations as they affect available and effective manpower. They represent medical care directed toward preventive ends.

Preventive medicine has likewise developed far beyond its original interest in the control of the communicable diseases and a concern of environmental sanitation. The prevention of disease in general, whether it be communicable or non-communicable, is now an established part of the progran for prevention, together with an interest in the limitation of traumatic and other injuries. In military practice, clinical and preventive medicine have become so nearly equal in emphasis that medical influences in military operations might be approached equally well from a consideration of the strategic and tactical influence of health, as from the standpoint of disease.

ADMINISTRATIVE MECHANISMS IN MILITARY MEDICINE. Since the responsibility for health is a function of command, it follows logically that need exists for a command adequately informed of health activities and health methods. The medical officer and the other technical experts of the Medical Department charged

with health matters through delegated responsibility, have equal need for an appreciation and understanding of military matters. The failure of a commander to understand and evaluate medical risks can be just as costly as to misjudge the fire power of the enemy. A lack of understanding on the part of the physician of that fine balance between military necessity and medical losses can be similarly inhibitive of the common effort which is the successful prosecution of a campaign. No remote suggestion is advanced in discount of the idealism that characterizes the practice of medicine; that is one of the finest parts of the profession, but war is not an idealistic business. It becomes necessary at times to look upon the health problems of a command from the standpoint of the group, to accept minor losses in order to effect major gains, and to weigh cost against military objective. The physician in military practice soon comes to appreciate that much of what he hopes to accomplish depends upon the support, the understanding and the aid that comes from his commanding officer. The medical officer must be equally cognizant of the objectives and requirements of command, for the measure of common accomplishment is generally determined by how well they understand each other.

These considerations are introduced because they are believed fundamental to an understanding of the influences that disease exerts on the conduct of war in the field, and to proper interpretation of the health record that results. This being the primary purpose of this presentation, rather than the methods and organization involved, a brief consideration of the 3 lines of approach to the management of health matters will suffice.

Command is called upon for a good deal more than intelligent understanding and direction of health activities. There is need for active participation. The good commanding officer gives interest and attention to the clothing, equipment and general well-being of his men, as well as to the adequacy of their training and the state of their military bearing. General Patton was the soldier, his primary concern with strategic and tactical matters. Perhaps that was the reason for his interest in the program of nutrition sponsored by the Medical Department, namely, that it fitted so logically into the framework of his strategic and tactical interests.

The direct responsibility for provision of medical care to the sick and wounded falls wholly upon the Medical Department. The elaborate provision for casualties in the forward areas during the war just past has been thoroughly and adequately described, from battalion aid stations, to collecting and clearing stations and to definitive care of non-transportable cases in field hospitals, or in sections of field hospitals to which auxiliary surgical teams were attached. The chain of evacuation extended to evacuation hospitals and back through the lines of communication to the great general hospitals. Station hospitals cared for the needs of troops of the Communications Zone and of those of rest and reserve areas; and back of all were the major facilities of the Zone of the Interior for those seriously incapacitated or with disabilities of long duration.

A fundamental difference between the services directed toward medical care and those of preventive medicine is that successful accomplishment of the latter depends to a far greater extent on a cooperative effort of all arms and services. The supervision and control of preventive activities is, to be sure, a function of the Medical Department and much of the technical service is provided by that part of the army; the inspection and control of food supplies of animal origin by the Veterinary Corps; and the laboratory services so essential to the modern program of prevention. The unit surgeon is the health officer of his organization and he is aided by the special divisions of preventive medicine which are a part of all major commands. These strictly medical activities are however only a part of the comprehensive program for prevention. The Corps of Engineers has responsibility for the provision of potable water, the disposal of sewage and refuse and other activities which enter into the program for environmental sanitation. The food program of the army brings into play a close cooperation of Medical Department and Quartermaster Corps. The Medical Department is charged with the adequacy of the ration, the Quartermaster Corps provides it to troops and assures its quality. The design and provision of satisfactory clothing and equipment are other responsibilities of the Quartermaster which relate strongly to matters of health. The provost Marshal finds direct participation in health

activities by way of the program for control of venereal disease, and the prevention of accidents. The Chaplain also has a concern with venereal disease control, and a still broader interest through matters of psychologic and moral well-being which enter so largely into the health of an army. The Special Services Corps was a principal agent in public health education. In summary, preventive medicine in the army as in civilian practice depends for its success upon a community effort. It succeeds in its objectives to the extent that the various arms and services are brought into a common program.

CLASSES OF MILITARY CASUALTIES. Military casualties are divided into 3 categories, those of battle casualties, non-battle injuries and those the result of disease. Disease is thus set apart from injury as a source of disability, with a further distinction of injury as it relates to battle or non-combat origin. The separation of the many conditions involved is generally clear-cut, but for some the decision is made arbitrarily. Trench foot contracted by soldiers in the line is classed as a non-battle injury, although reasons of lesser moment have been advanced in claim of combat status. It is likewise evident that similar events are classified differently according to the circumstances under which injury took place. A gunshot wound of the hand incurred accidentally in a training area, or contracted anywhere as a self-inflicted wound, is a non-battle injury, and distinct from the battle casualty that results through contact with the enemy. The definition of terms that follow is from Army Regulations.

Patients are classified according to the primary cause of initial admission and reported in 1 of 3 categories of cases: disease, injury, or battle casualty. In instances of patients suffering from both disease and injury at the time of initial admission, the most serious condition present is taken as the primary cause of initial admission and determines the classification. Patients admitted for a battle casualty and a disease or injury are classed as a battle casualty.

All cases other than those due to injury or battle casualty are classed as "disease." Included among the disease cases are patients suffering from reactions to medication other than acute poisoning, patients admitted for the sequela of an injury incurred prior to entering service, and patients readmitted for the results of a traumatism (battle or non-battle) incurred during service.

The term "injury" includes traumatisms other than those defined as "battle casualty." The term "traumatism" refers to morbid conditions due to external causes. It includes acute poisoning, except food poisoning, the results of exposure to heat, cold and light as well as various types of wounds.

A battle casualty is a traumatism (wound or injury) which is incurred as a direct result of enemy action during combat or otherwise, or is sustained while immediately engaged in, going to, or returning from a combat mission. It does not include traumatisms occurring on purely training flights or missions. Psychiatric cases occurring in combat are not reported as battle casualties.

The measurement of losses from what-ever cause is accomplished by computation of rates that relate to 3 principal demographic characteristics. The first of these, mortality, is the expression of the number of deaths from a particular cause that occur per unit of population and time, the ordinary unit of population being 1000 men and the interval of time 1 year. The rates for shorter periods are based on the assumption that the observed frequency would have continued over a year. The mortality rate represents a definite and certain military loss, irrespective of cause, of time or of nature, and is one of the absolute indices of the cost of war.

The morbidity rate expresses the number of persons affected by a given condition as determined by patients admitted to hospital or quarters, in relation to the same units of population and time as serve for mortality. Morbidity rates as so defined do not represent all persons affected but only those seriously enough involved to be absent from duty. Nevertheless, these indices of illness as employed in military practice are more satisfactorily indicative of the existing situation than is usual in public health or preventive medicine, because reporting is particularly good. The interpretation of the significance of any particular

morbidity rate as an influence on tactical and strategical operations depends, in the first instance, on the duration of the disability ordinarily associated with the condition; secondly, on the expected fatality; and finally on the probability for complete recovery and return to duty.

The commander of a military organization ordinarily finds the daily non-effective rate the most valuable single index of the health of troops. As the term indicates, this is representative of the number of men absent from duty by reason of disease or injury for each 1000 troop strength per day. The complementary value shows the proportion available for duty at any prescribed time.

NON-EFFECTIVENESS IN THE EUROPEAN THEATER. Experience of the European Theater of Operations in respect to non-effectiveness of troops by reason of medical disability is shown in Figure 1. It is to be noted here that these data and all others included in this study are from field records and therefore subject to revision and correction when the final analysis of individual case records as eventually completed. The provisional data are believed sufficiently reliable to establish relationships and trends. Some are from theater sources; a great part were made available by the Division of Medical Records, Office of The Surgeon General, United States Army.

Discounting the early part of 1942 when the small troop strength accounted for irregularities in the demonstrated pattern, each year of the 4 year period of World War II saw the high point of non-effectiveness centered about the early months of the calendar year and minimal values during the summer. The seasonal incidence of upper respiratory infections was the dominating influence. Variations from year to year were not great until the latter part of 1944 when the values for all months increased precipitately over the established norm. This was coincident with the beginning of active operations in Continental Europe.

The division of this particular experience into the 3 components which make up the total non-effective rate (Fig. 2) gives ready demonstration of the factors involved. The non-effectiveness related to disease continued according to established pattern, with rates in 1945 almost identical with those that characterized 1944, the year just preceding the campaign. A significant part of the excess non-effectiveness came about through a greater frequency of non-battle injuries, principally trench foot. The most important variable was that of battle casualties, the data of Figure 2 demonstrating clearly that the high non-effectiveness of the campaign period was due to that cause.

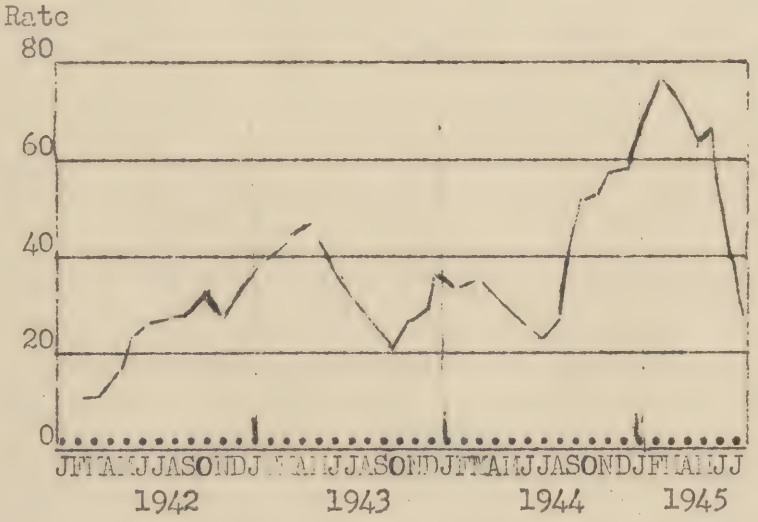

Fig. 1. - Average daily non-effective rates per 1000 strength, European Theater of Operations, U.S. Army, by months, February 1942 to June 1945 inclusive.

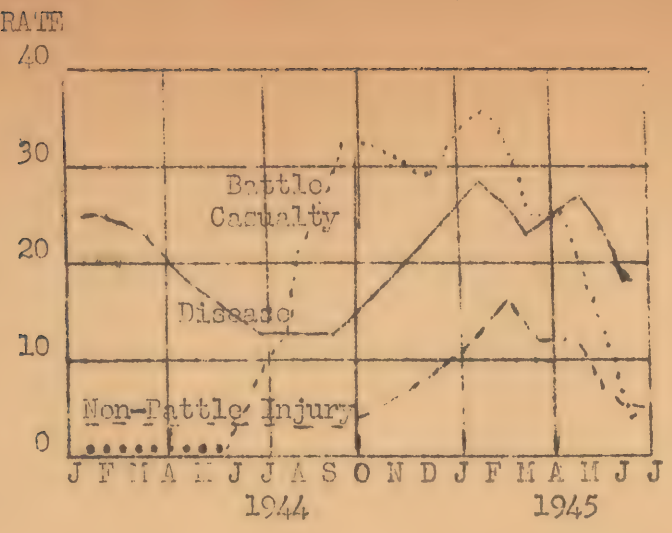

Fig. 2. - Average daily non-effective rates per 1000 strength, disease, non-battle injury and battle casualty, European Theater of Operations, U. S. Army, January 1944 to June 1945 inclusive.

The generalizations to be drawn from this experience are that year in and year out the principal cause of non-effectiveness of troops is disease. The losses from non-battle injuries are ordinarily much less, about one-fifth those from disease. The non-effectiveness that comes from battle casualties is subject to great variation and is wholly related to the nature of operations. The impression is not to be left that the cost in battle casualties is unpredictable, for the expected losses in a major operation can be computed with an exactness rivalling that of disease and injury.

It is noteworthy that the rates for all 3 classes of casualties are susceptible to irregular fluctuations which can be related with much certainty to environmental, seasonal, or other ecologic factors.

The peaks of excess incidence that mark the behavior of battle casualties and non-battle injuries are as outstanding as any introduced into the curve for disease through action of an epidemic in the common definition of the term.

DISEASE AS A FACTOR IN MILITARY OPERATIONS. That disease as a cause of death and disability has become a matter of far less significance in the wars of the past half-century is a matter of general knowledge. It is not so generally appreciated that the changes that have occurred are qualitative as well as quantitative.

The ratio of deaths from disease to deaths from battle casualties for the wars of the 18th and 19th centuries was sometimes as great as 13 to 1. A generally accepted ratio was 4 to 1, as for example, in the Turko-Russian War of 1877-78 where deaths from disease numbered approximately 80,000 and those from battle casualties 20,000. The ratio during the campaign in the Crimea was even greater, with some 70,000 deaths from disease and 7500 from battle casualties among the French forces. Essentially two-thirds of the deaths that occurred in the Union Army during the American Civil War were from disease, which marked an improvement over the Mexican War of 1846-47 when deaths from disease outnumbered those from battle casualties 7 to 1. The record during the Spanish-American War was less satisfactory, with an excess of deaths from disease over losses in battle in the proportion of about 13 to 1.

Fewer deaths from disease than from battle casualties were noted for the first time (Table 1) in the War of 1864 which Denmark waged against Austria and Prussia. Both opponents established a ratio of 1 death from disease to 2 for casualties of battle. The number of men engaged in that war was small, communications between the armies and home countries were good and environmental conditions were favorable; and yet this was a remarkable event, a turning point in the history of wars. The Franco-Prussian War of 1870-71 was the first major war to see the new ratio maintained, by the German Army with a proportion of 0.86

deaths from disease for each battle casualty. The health record of the German Army has indeed been consistently good, for of 5 wars, dating from the Danish action of 1864 and including World War II, deaths from disease have been less than those from battle casualties with the single exception of the War of 1866 and that was close to parity. The Russo-Japanese War of 1904, the next great conflict after the Franco-Prussian War, gave the Japanese forces an opportunity to set a new record of 0.37 deaths from disease per battle casualty. World War I was the first American experience in which a similar result was attained, providing troops in the active European campaign of 1918 be considered (Fig. 6). For the army as a whole and representative of all men under arms the ratio was still in favor of disease (Table 1). World War II brought a complete departure from previous experience, and a health record never approached previously in any war.

The gains which have been made in recent times in the cost of disease are primarily due to improved control of acute infectious processes. Not only are deaths far less frequent in proportion to those at risk, but the incidence of communicable disease is decidedly less. This has brought significant changes in the qualitative character of the losses that still result from disease as distinguished from injury and battle casualties. Non-communicable disease has become a far more significant consideration. That the frequency of this class of disability had a direct relationship to military operations is illustrated by the data of Figure 3.

During the time that active combat operations involved only a small proportion of American troops in Europe, those of the Air Force based in Great Britain, the rates for neuropsychiatric disease were fairly stable and at a satisfactory level. For the whole experience, admissions for this cause constituted about 7% of all disease. The influence of major field operations is evident in the rise in frequency that took place in the summer of 1944 when the continent of Europe was invaded. The excess incidence was as sharply defined, and interjected as precipitiously, as that of any epidemic of acute upper respiratory infection or other communicable disease. In July 1944, about one-fourth of medical admissions were of this class. As the pressure of assault operations was relieved, the frequency of neuropsychiatric conditions declined as promptly as it had arisen; despite the fact that this was a period of relatively active field operations marked by the rush across France and the approach to the German border. The outstanding difference was that this was a conquering army, with rapid and successful advance against an enemy that offered little resistance.

Table 1. - DEATHS FROM DISEASE AND DEATHS FROM BATTLE CASUALTIES IN THE PRINCIPAL WARS OF THE PAST 100 YEARS

War	Deaths		
	Disease	Battle	Disease:Battle
Mexican War, 1846-47 (United States)....	10,986	1,549	7.03:1
Crimean War, 1854-56 (French).....	70,000	7,500	9.33:1
Civil War, 1861-65 (Union Troops).....	186,216	76,216	2.44:1
Danish War, 1864 (German).....	310	738	0.42:1
(Danish).....	820	1,446	1.57:1
German War, 1866 (German).....	5,219	4,008	1.30:1
Franco-Prussian War, 1870-71 (German)...	14,904	17,225	0.86:1
Russo-Turkish War, 1877-78.....	80,000	20,000	4.00:1
Sino-Japanese War, 1894-95 (Japanese)...	15,850	1,311	12.09:1
Spanish-American War,1898(United States)	4,795	379	12.65:1
Philippine Insurrection,1898-1902 (United States)	4,409	1,036	4.26:1
Boer War, 1899-1901 (British)	11,377	6,425	1.77:1
War in South-West Africa,1904-07(German)	689	802	0.86:1
Russo-Japanese War,1904-05(Japanese)....	21,802	58,257	0.37:1
(Russian, less Port Arthur).....	18,830	23,008	0.82:1
World War I, 1914-18 (French).....1,750,000		924,700	1.89:1
(German).....	155,013	1,531,048	0.10:1
(United States, all troops)...	58,119	50,385	1.11:1
(United States, A.E.F.Europe).	21,314	50,385	0.42:1
World War II, 1939-45 (United States, European Theater).....	1,432	122,384	0.012:1

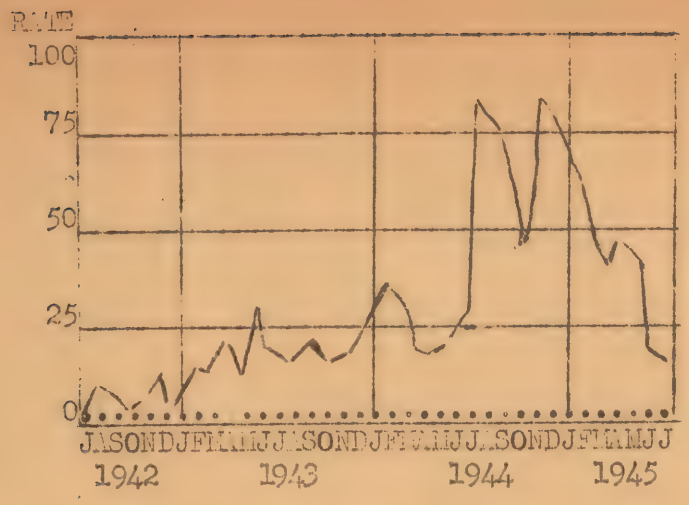

Fig. 3. - Neuropsychiatric conditions, admissions to hospitals and quarters, European Theater of Operations, U.S.Army, rates per 1000 strength per annum, by months, July 1942 to June 1945 inclusive.

The frequency of neuropsychiatric disease again rose sharply when the attack was resumed in November; and a second peak of excess incidence duplicating that of the first was associated with the stubborn active defence action brought about by the Battle of the Bulge. Thereafter, the rates declined progressively and in marked degree, despite the active offensive action of February, March and April, when the Rhineland was invaded and the Inner Reich eventually occupied. The rates then were little more than during the relatively peaceful days in Great Britain before the continental campaign got under way.

The changing character of losses from disease is equally well illustrated by the kinds of conditions that entered into mortality rates from that cause in the European Theater. Considering the entire period of operations, 5 more deaths were recorded from alcohol poisoning than from all communicable processes combined, to include not only the usual epidemic diseases, but all other infectious processes such as tuberculosis and the pneumonias.

By either of the 2 principal criteria by which the effects of disease are judged, mortality and morbidity, the communicable diseases have decreased significantly as a factor of importance in military operations. Qualitatively the non-communicable processes have attained a significance out of proportion to previous experience. The effect that these changes have had on the total losses from disease are illustrated to advantage by an examination of the experience of the European Theater of Operations during World War II, as compared with the American Expeditionary Forces of World War I.

For each of the 4 years that the European Theater was in existence, disease was far and away the most frequent cause of admission to hospital or quarters (Fig. 4). The highest rate was in 1943, the widespread epidemic of influenza that occurred in the autumn of that year being the chief determining factor. The rates from year to year showed little variation, irrespective of whether the battle was fast or slow. A direct correlation between the activity of military operations and the frequency of disease was lacking. The numbers of persons affected were regularly great, since 1 out of 2 soldiers tended to suffer each year some disability from disease of sufficient degree to interfere with military duties. The regularly occurring annual peak of incidence in late autumn or early winter (Fig. 5) serves to demonstrate the overwhelming importance of acute upper respiratory infection as the dominant factor in morbidity for this class of disability

No particular significance attaches to the experience of the first 2 years of the European Theater. The morbidity rates for disease were in all respects satisfactory and the health record good. The striking feature becomes evident in respect to the last 2 years. During the height of the campaign, which started in the middle of 1944 and ended in the early summer of 1945, the morbidity rates for disease as judged by admission to hospital and quarters was at a lower level (Fig. 5) than at any other time during the war. Proverbially and throughout the history of wars this is the time when losses have been great. Granted that many

soldiers will not report sick during the height of military operations, and particularly in time of advance, nevertheless the fact that so few were seriously disabled by disease is perhaps the clearest evidence that could be advanced of the progress that has been made in environmental sanitation and in the practice of preventive measures. While disease ranked first among the 3 major categories of military casualties as a cause of disability, it was the least important as a cause of death. The absolute rate, 0.5 per 1000 strength per year, was inconsequential when compared with death rates for disease in other wars of this country, or indeed within the history of warfare.

The 2 European Wars of the United States offer an opportunity for comparison of the changing trends in causes of death among military casualties (Fig. 6). Battle casualties were the principal cause in both instances, but disease dropped from a strong second place in 1918 to a good third in World War II. Deaths from non-battle injuries in the recent war exceeded deaths from disease in a greater proportion than deaths from battle casualties had exceeded disease in World War I. Comparing directly deaths from battle casualties and disease in the 2 wars, the ratio in the European phase of World War I was slightly better than 2 to 1; in the second war about 92 to 1.

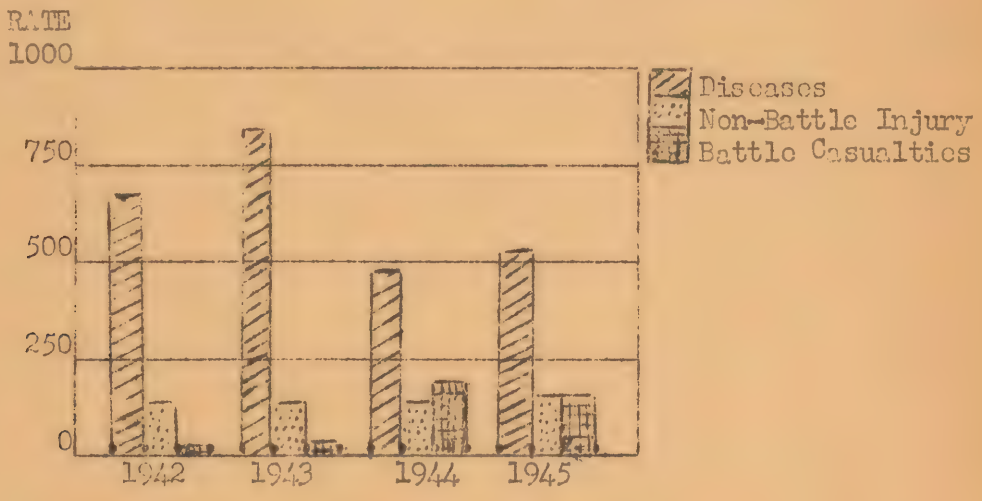

Fig. 4. - Admissions to hospitals and quarters, all causes, European Theater of Operations, U.S. Army, rates per 1000 strength per annum, February 1942 to June 1945 inclusive.

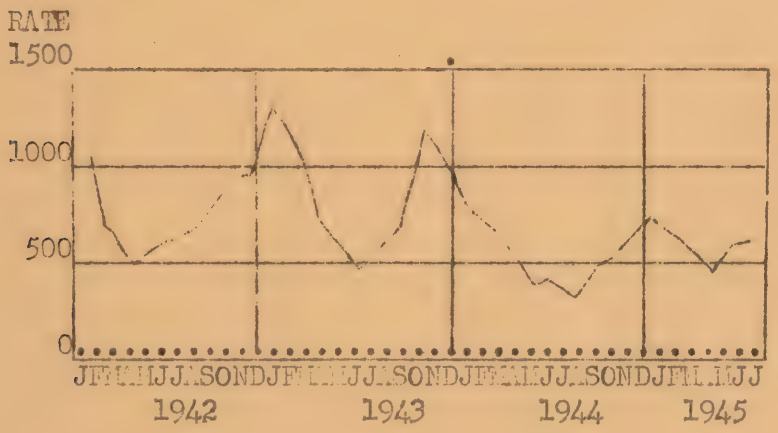

Fig. 5. - All diseases, admissions to hospitals and quarters, European Theater of Operations, U.S. Army, rates per 1000 strength per annum, by month February 1942 to June 1945 inclusive.

Losses from battle casualties are difficult to compare because so much depends upon the type of campaign and the development of weapons of war. These 2 campaigns were fought in the same general region and against the same enemy; to that extent the comparison is reasonable. At any rate, deaths from battle casualties were proportionately less in World War II than in World War I and it is reasonable to interpret that difference as related to improved methods of

medical care. Expectedly the active open warfare of the more recent experience would lead to a greater proportion of casualties than the static trench warfare which characterized so much of operations in 1918. While the differences in death rates from battle casualties during the 2 wars is not great, that in respect to disease is most striking. The losses in 1942-45 were but a fraction of those of the previous experience, essentially one-fortieth. Only in respect to non-battle injuries did the death rates of World War II rival those of World War I. The rates were almost identical despite the greater hazards associated with a more highly mechanized warfare.

The experience thus far presented in respect to the casualties resulting from disease in World War II have related wholly to the European Theater of Operations. The experience for all 9 theaters of operation through June of 1945 is presented in Table 2, but carries no suggestion of a comparison of results or an attempted measurement of accomplishment in these several areas of military activity. It is wholly evident that losses from disease are subject to great variation according to differences in environment, the kinds of risk to which troops are subjected, the prevailing health hazards, and the prevalence of particular communicable diseases. It is, however, a matter of satisfaction that where environmental conditions were similar and risks comparable, the morbidity rates for disease in overseas theaters compared favorably with those experienced by troops stationed in continental United States, which was 653 per 1000 strength per annum. Four theaters actually had better rates, although allowance must be made for the problems associated with recruits in the Zone of the Interior, and the greater resistance of seasoned troops who went overseas.

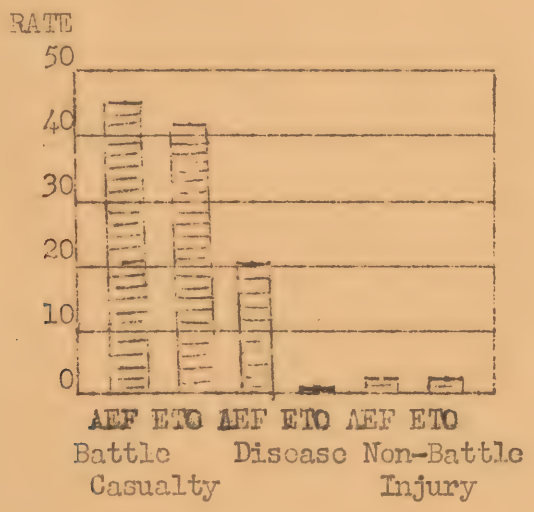

Fig. 6. - Causes of death in World Wars I and II, troops of the AEF (April 1917 to December 1918 inclusive) and of the European Theater of Operations (February 1947 to June 1945 inclusive), U.S.Army, average rates per 1000 strength per annum.

The North American Theater had the best morbidity rate for disease of all forms, 534 per 1000 strength per year. The European Theater, the largest in respect to troop strength, was next. The highest morbidity was experienced by troops of the Africa-Middle East Theater, followed closely by those stationed in the China-Burma-India area and in the South-West Pacific. The admittedly greater hazard of the Mediterranean area of Europe as contrasted with northwest Europe is reflected in average annual rates for disease of 849 and 546 per 1000 strength per year.

The analysis of the component causes which served to determine these rates, and a comparison of experience between theaters, is beyond the scope or intent of this presentation. The results universally obtained in respect to a particular disease long recognized as a peculiar hazard of war, are nevertheless so striking as to deserve special mention. In the European Theater of Operations where battle casualties were more numerous than in any other theater, both the mortality and the morbidity rates for tetanus were less than among troops stationed in continental United States, thousands of miles from a field of battle. The almost unbelievably good results, a single case and a single death during the whole period of operations in Europe, are attributable to the remarkable effectiveness of active immunization brought about by tetanus toxoid. No soldier left America

without immunization and the greater rates in the Zone of the Interior, of themselves inconsequential, were related to tetanus infection among recruits before immunization had been accomplished. The detailed circumstances of this experience in all theaters of operation have been presented by Long and Sartwell.

TABLE 2. - ALL DISEASES, ADMISSIONS TO HOSPITALS AND QUARTERS, TOTAL ARMY, CONTINENTAL UNITED STATES AND THEATERS OF OPERATIONS, U. S. ARMY (CASES AND RATES PER 1000 STRENGTH PER ANNUM, BY YEARS, JANUARY 1942 TO JUNE 1945, INCLUSIVE.)

	Total		1942		1943		1944	
Theater	Cases	Rate	Cases	Rate	Cases	Rate	Cases	Rate
Total Army	14,120,214	667	2,047,606	671	5,163,760	768	4,550,658	606
Continental United States	8,578,265	653	1,699,134	699	3,793,588	739	2,261,800	564
Total Overseas	5,541,949	690	348,472	679	1,370,172	860	2,288,858	654
Africa-Middle East	123,336	946	7,783	1356	59,073	1107	42,468	896
China-Burma-India	308,806	929	5,951	1046	45,636	991	171,716	1077
Southwest Pacific	1,117,120	926	55,751	832	204,267	1046	465,289	840
Mediterranean	1,148,934	849	9,618	451	406,619	943	558,051	846
South America	235,832	676	84,864	825	82,748	684	46,448	540
Pacific Ocean Area	626,954	600	72,812	494	239,851	813	221,457	561
Alaska	155,041	571	33,564	668	71,615	624	39,766	478
Europe	1,735,263	546	50,881	700	221,078	837	725,437	492
North America	90,663	534	27,248	672	39,285	548	18,226	433

(continued)

	1945	
Theater	Cases	Rate
Total Army	2,358,190	609
Continental United States	823,743	571
Total Overseas	1,534,447	631
Africa-Middle East	14,012	587
China-Burma-India	85,503	707
Southwest Pacific	391,813	1006
Mediterranean	174,646	726
South America	21,772	558
Pacific Ocean Area	92,834	448
Alaska	10,096	431
Europe	737,867	538
North America	5,904	382

Source: Medical Statistics Division, Office of The Surgeon General, War Department, Washington, D.C.

World War II involved more men and extended over a greater geographical area than any other in history. The successful result that accrued to the American arms was influenced in forceful degree by the action of favorable casualty rates for disease previously without precedent. The overall results speak for themselves. The extent to which disease influenced individual campaigns remains to be examined, first in respect to long-term strategic action and secondly as an immediate tactical influence.

STRATEGIC INFLUENCE OF DISEASE. Rarely does the practice of epidemiology on the grand scale reach such potentialities as in war. The epidemic of typhus fever that eventually involved American troops in Germany in 1945 constitutes an outstanding example of the strategic influence of disease in field operations. The epidemic was evident well in advance of the time that it became an immediate military problem, with the result that plans and an organization for meeting the situation got under way as early as 1941.

The probable situation at different times in the projected course of military operations was analyzed in detail. Arrangements for a cordon sanitaire along the Rhine River with tentative ports of entry were set up 3 years before an American soldier crossed that river. A significant change in procedure was incorporated in the plan in 1944 when the value of the newly developed insecticide DDT became evident. Unit responsibility for control measures in the particular area of influence was recognized as the fundamental approach. Provision was made at theater and army echelons for teams trained in diagnostic and insect control procedures to furnish the necessary aid and consultation to unit surgeons. The proper administration of the cordon sanitaire was made the responsibility of the army group.

Typhus was found in Germany in March 1945 as anticipated, in all a total of 17,000 cases. The number of secondary infections was surprisingly few. The outbreak was eliminated within 3 months. During this time only 3 American soldier contracted the disease, 2 of them physicians engaged in typhus control. The results contrast with that took place in 1918, although at that time material progress had already been made in knowledge of this epidemic disease and in measures for its control. More than 5,000,000 persons had typhus fever in Russia alone and deaths have been estimated at 2,000,000; in Serbia essentially one-fifth of the population was involved in the epidemic, with 150,000 deaths in a 6 month period of 1915. The potentialities for a similar major epidemic in 1945 were decidedly great, for the existing circumstances were not dissimilar from those of 1918. The difference in result was determined by the advances in technical knowledge that had taken place within recent years, and the new measures for control that were provided. It depended upon careful planning at staff levels, adequate provision of supplies, organization of the special United States of America Typhus Commission, and finally the thorough mobilization of the field medical services who did the work of control. From a strategical standpoint, the casualties from this cause among military personnel were negligible. Not a single death occurred from a disease recognized as one of the great pestilences of man, and characterized by a notably high fatality. Still more important was the absence of any interference with military operations at a critical time in the developing final offensive. The army suffered no significant losses itself, nor was it called upon because of typhus to provide medical and other care to an overwhelmed civilian population of occupied territory.

Malaria in the Southwest Pacific constituted a strategic problem of equal importance to that of typhus fever in Europe. Advance planning had likewise been concerned with the provision of malaria control supplies, the development of method, and the training of personnel to combat this communicable disease. The early years of operations in that theater were attended with shipping difficulties It is a function of theater authority to allot tonnage and a choice had to be made among the various classes of supplies assembled at ports of debarkation. The choice was made with the result that troops taking part in the early campaigns in the Solomons and in New Guinea were without sufficient malaria control supplies and lacked specially trained control organizations. The casualties from malaria were high. In the South Pacific Area the attack rate for malaria reached 696 per 1000 per year in August 1943. In the Southwest Pacific Theater the attack rate early that year exceeded 400. Four American and 2 Australian Divisions were incapacitated for periods of more than 6 months. At one time more than 30% of available beds in the Southwest Pacific Theater were occupied by malarial patients Subsequently the situation improved greatly. Survey and control units were assigned to field control, the necessary supplies were shipped and strong emphasis was placed by command on the improvement of malaria discipline among troops. The morbidity rate for malaria declined steadily during the latter half of 1943, and in 1944, so that by 1945 the attack rate was less than 40 cases per 1000 troop strength per year in the better areas. The extent of the problem is indicated by the loss of 800,000 man days from malaria in the Southwest Pacific Theater in 1943, this constituting a fourth of the losses from all disease. The proportion was reduced to 5% in 1944; and the old ratio of greater losses from disease than from battle casualties again returned to the more favorable circumstance which characterizes modern warfare. The strategic problem was met, but after avoidable losses.

The principle in facing a problem where the influence of disease is involved, is a question of how many effectives can be maintained in the line. Medical weapons and medical supplies may be as important a consideration as the number of troops made available or the basic military supplies of ammunition, rations and motor fuel.

NON-BATTLE INJURY AS A STRATEGIC AND TACTICAL INFLUENCE. The experience of the European Theater of Operations may be taken in illustration of the regularity with which losses from this class of military casualty occur. Irrespective of whether operations relate to a time of training or to an active campaign in the field, the number of men lost by reason of non-battle injuries is subject to little variation (Fig. 7). The rate for the year 1944 was actually the best of the 4 years despite the autumn campaign in France and appreciable losses in the last 2 months of that year from trench foot, a major item in the category of non-battle injury. The excess rate for 1945 was almost wholly of that origin and yet the rate for the year was not greatly in excess of the first training year of 1942.

The attack rate for disease was much greater than that for non-battle injury, varying from a ratio of 8 to 1 in the most unfavorable year to a relationship of 5 to 1 under the most favorable conditions (Fig. 4). The difference between the 2 conditions is less marked when judged on the basis of the resulting non-effectiveness, since the period of disability from injury is longer than that for disease (Fig. 2).

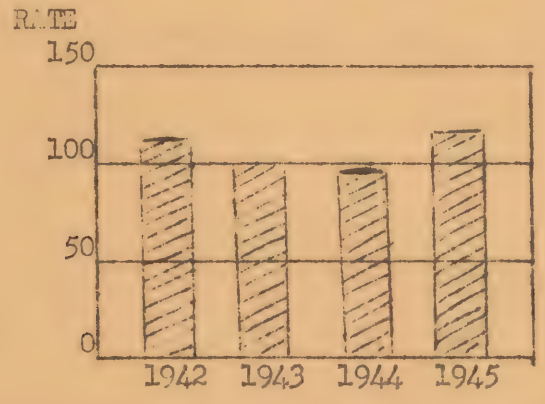

Fig. 7. - Non-battle injuries, admissions to hospitals and quarters, European Theater of Operations, U.S. Army, rates per 1000 strength per annum, February 1942 to June 1945 inclusive.

A comparison of morbidity rates for non-battle injury in the several theaters of operation shows a variation in experience considerably less marked than for disease (Table 3). Without exception, casualties from non-battle injury were more frequent in theaters of operation than in continental United States, since no theater approached the average rate of 75 per 1000 strength per year established by troops of the Zone of the Interior. The influence of environment on the record attained was strongly evident. The Alaskan Theater with 1 of the best rates for disease had the highest rate for non-battle injuries, and conversely the China-Burma-India Theater, with a rate of 929 per 1000 per year for disease, had the admirable record of 95 for non-battle injuries. Again it is to be emphasized that no direct comparison between theaters can be made on the basis of these crude rates because environmental and tactical conditions varied greatly. The important consideration is that these are in large part preventable conditions, and the rate under a given set of conditions can be influenced by the extent to which preventive measures are applied. The important component conditions of motor accidents and trench foot are decidedly in point.

Trench foot in Attu, in Cassino and in the European Theater was a strategic problem of preventive medicine. The condition is an accompaniment of campaigns in wet cold climates. In a given week, in November 1944, 3000 cases occurred in a single field army. In the months that followed, all combat troops of the European Theater were involved in varying degree. Field control was strictly an epidemiologic problem. Attack rates were shown to bear a definite relationship

to the existing tactical situation. The risk varied as troops were on the offense, engaged in holding actions, under static conditions, or in rest areas. The kind of weather exerted an influence, likewise the character and amount of clothing and equipment. Qualities of the terrain could be demonstrated as a contributing factor and of decided significance were the methods of management of troops. The incidence was by no means uniform. Certain armies, divisions, regiments and even battalions suffered inordinately in comparison with neighboring units operating under similar environmental circumstances. Riflemen were affected beyond all other occupational army groups, with more than 90% of cases in this important component of the ground forces. The importance of this circumstance becomes evident when translated into terms of effective combat strength. A loss of 15,000 men from trench foot is seemingly the equivalent of 1 division and yet with 4000 riflemen to a division and 90% of the casualties within that group, the actual loss is 4 effective fighting divisions. The contributing causes of the condition and its incidence varied from place to place and from time to time. The principle of prevention is evident - an epidemiologic analysis of cause and effect (Fig. 8) and a fitting of control measures to the individual circumstances.

TABLE 3. - NON-BATTLE INJURIES, ADMISSIONS TO HOSPITALS AND QUARTERS, TOTAL ARMY, CONTINENTAL UNITED STATES, AND THEATERS OF OPERATIONS, U.S.ARMY (CASES AND RATES PER 1000 STRENGTH, PER ANNUM, BY YEARS, JANUARY 1942 TO JUNE 1945, INCLUSIVE)

	Total		1942		1943	
Theater	Cases	Rate	Cases	Rate	Cases	Rate
Total Army	1,921,342	91	294,288	96	624,849	93
Continental United States	987,163	75	230,366	91	412,655	80
Total Overseas	934,179	116	63,922	125	212,194	133
Alaska	41,341	152	7,619	152	20,852	182
Southwest Pacific	166,758	138	11,963	178	33,317	171
Mediterranean	179,581	133	2,040	96	64,075	149
North America	21,160	125	6,330	156	9,747	136
Africa-Middle East	14,679	113	928	162	7,469	140
Pacific Ocean Area	111,366	107	15,379	104	33,590	114
European	335,445	105	8,023	110	26,497	100
China-Burma-India	31,541	95	460	81	3,893	84
South America	32,308	93	11,180	109	12,754	105

(continued)

	1944		1945	
Theater	Cases	Rate	Cases	Rate
Total Army	666,209	89	335,996	87
Continental United States	270,536	67	73,606	51
Total Overseas	395,673	113	262,390	108
Alaska	10,558	127	2,312	99
Southwest Pacific	77,046	139	44,432	114
Mediterranean	91,063	138	22,403	93
North America	4,065	96	1,018	66
Africa-Middle East	4,712	99	1,570	66
Pacific Ocean Area	43,648	111	18,749	90
European	143,201	97	157,724	115
China-Burma-India	15,385	96	11,803	98
South America	5,995	70	2,379	61

Source: Medical Statistics Division, Office of The Surgeon General, War Department, Washington, D.C.

Three times in the course of World War II, trench foot was encountered as a strategic problem and 3 times the losses were beyond calculated risk or reasonable expectancy. The invasion of the Japanese mainland would have presented a fourth situation, for the environmental conditions predisposed in a degree comparable to those of Italy and northwest Europe. The combined opinion and effort of several arms and services went into the development and initiation

of a plan which included the chief considerations of clothing and supplies, education of the individual soldier, the organization of special trench foot control units, and the administrative action of command. What was done never came to test, for hostilities ended before Japan was invaded. It behooves any future planning group concerned with a campaign in wet cold climates to review that plan.

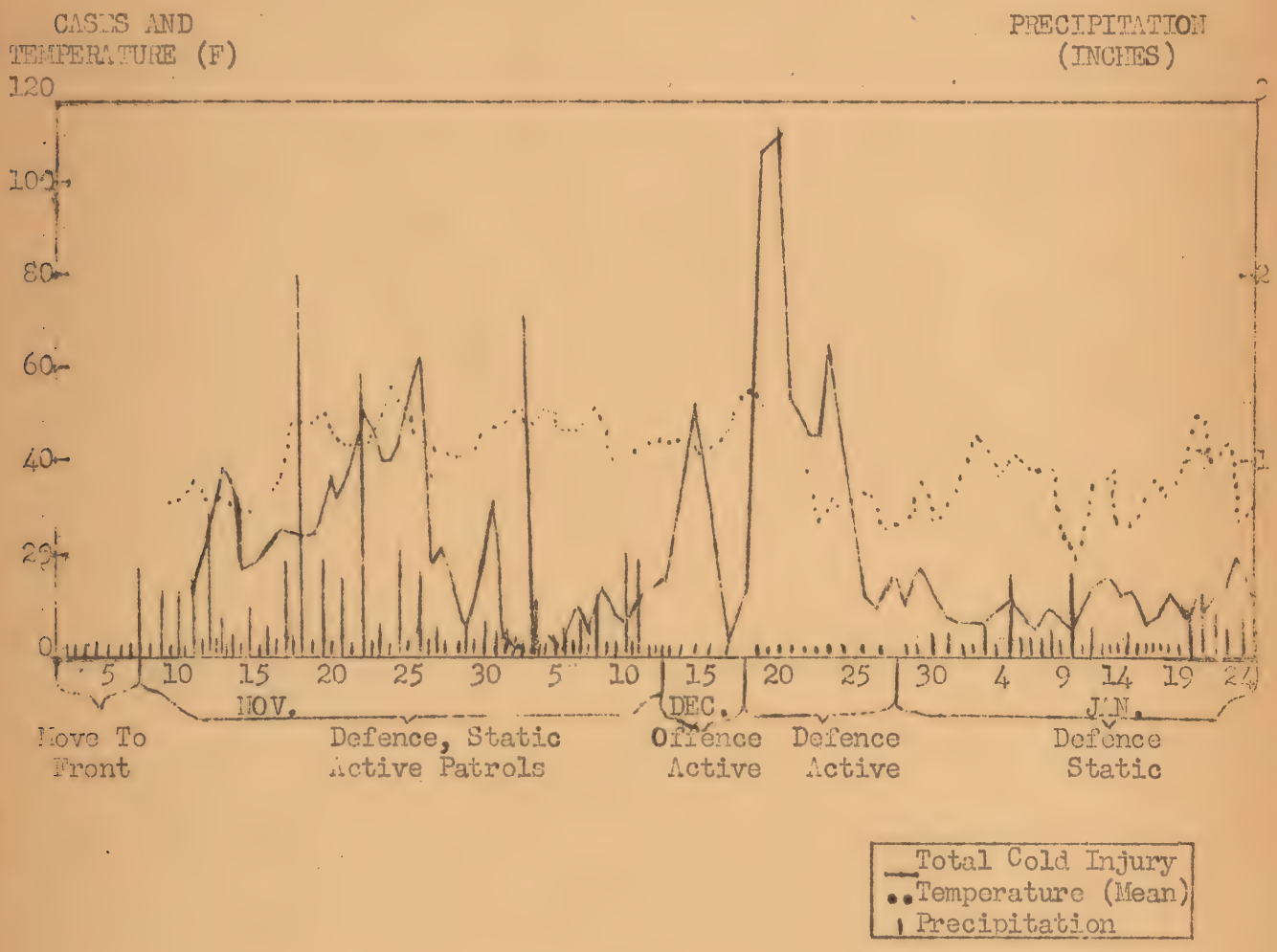

Fig. 8. – Cold injury in an infantry division, frequency of cases by type of military operation, temperature (°F.) and precipitation in inches.

UNITED STATES MILITARY ACADEMY, West Point,

Department of Military Hygiene

Colonel Charles L. Kirkpatrick, M.C., Professor

Lecture V

Military Responsibility in Civil Public Health -
a. Civil Defense
b. Occupation

Instructor - Colonel W. L. Wilson, M.C.
Office of The Surgeon General
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Washington, D.C.

MILITARY RESPONSIBILITY IN CIVIL PUBLIC HEALTH
16 and 17 September 1948

What is public health? I like a definition advanced by Winslow, that is "the art and science of preventing disease, prolonging life and promotin physical and mental efficiency through organized community effort." Assuran of satisfactory public health is one of the important functions of civil gove ment in every community, whether federal, state or local.

There will be circumstances under which responsibility for administration of both military and civilian communities will rest solely upon a military commander, during which not the least important of many administrative functions will be the prevention of disease, the prolonging of life and the promoting of physical and mental efficiency through organized effort of the community itself. The degree to which the military commander understands this responsibility in peace is essential, but in modern, total war it may determine the ultimate measure of his nation's success and will determine whether posterity judges him as a great leader. He may succeed if he understands the function and knows how and is willing to employ his technical staff, particularly his medical officer. This short discussion cannot assure your success, but it will be justified if your interest is stimulated, if you obtain a general concept of the grave responsibilities involved, the circumstances under which you might be responsible, and if we suggest to you the means available and methods by which you can prepare yourself for the job. Remember two important requirements - always be reasonable, and be sure you can justify your actions.

One day you will individually or collectively be responsible for civilian health at home among your own people, abroad among friendly or allied people, or at home or abroad in the presence of a public enemy. We should consider a few things you will want to know.

The civil or community public health and military public health can be separated with difficulty, if at all. Our Army is always a part of the community in which it is operating, whether the community is our own population or some other over the world. The Army seldom lives or functions separately from a civilian community. You will understand that the physical, mental, and spiritual make-up of the Army develops from the same community even as physicians and chaplains of the Army influence these factors among the troops, but let us briefly mention some of the reasons why the physician can aid you in health affairs so much. Army physicians have remained much longer in civilian existence and under civilian influence than you in the military business who were brought under military guidance and teaching relatively early in adult life, and by necessity continue there.

Doctors completed their education outside of the Army and will continue their training in direct contact with their civilian confreres throughout their professional careers. No one can become a physician in this country except by graduating from a purely civilian medical school. All Army medical officers have gone through the same education as civilian physicians, and medical officers continue to develop their medical specialties and qualify themselves in all fields of medicine by the same procedures as required for the finest civilian specialists The Army medical officer is always serving a military commander as a technical adviser and staff specialist, while the public health official is serving the civil administrator in a similar manner. So long as the Medical Corps is in direct contact with health administrators of federal, state and local governments at all times to maintain the health of the Army and the civilian community, these relationships offer perhaps the closest tie you may develop between Army officers and civilian counterparts.

All responsibility to the military or civilian community for the results rests upon the military commander and the civilian administrator, respectively. This is proper, for the medical man has no authority, except that derived through the military commander or the civilian administrator. Proper utilization of your medical officer, and reliance upon him for advice will generally bring desired results.

Civil affairs experiences may develop so gradually that officers are unaware of achievements just as important to a world community as their outstanding military successes. Although the Panama Canal was a single military achievement, General Goethals, as a cadet like you, could not have foreseen the effects of his engineering upon future civilian health over the world, or his name firmly established along with medical conquerors of yellow fever. Could General Pershing's military successes alone in France have had as much influence upon the world as the civil administrations during and after World War I? We surely would be unable to believe now that the combat successes achieved under General Eisenhower's command had any more ultimate importance than his civil affairs and military government functions. He considered them sufficiently important to implement them under an Assistant Chief of Staff (G-5), Civil Affairs Division in his general staff, along with the conventional four pre-war G's. The health of the Allied Expeditionary Force and the civil populations of the liberated countries, of the displaced persons, and of Germany, was so much one community problem it has influenced major international policies ever since, and major economic, social and other factors at home and abroad.

No commander can overlook his responsibility with respect to the civil public health when he considers recent military history. Civilian sources for typhoid fever in the Spanish-American War and influenza in World War I taught us that. Civilian malaria attacked British forces in the Holy Land and would have delayed, if not denied, Allenby's success if the enemy could have withstood him just a few days longer.

The civil public health in the Pacific in World War II demanded full command recognition before sources for malaria and dysenteries could be suppressed and military operations could proceed successfully.

What are some of the health services concerned? For convenience we can say that functional services in the United States are administered in four conventional groups:

1. Preventive services generally by health departments, operating under state sanitary codes.

2. Curative services by professional ministration, rendered under state laws of licensure and control of practice, in conjunction with government or non-government hospitals and other plant facilities which may or may not be licensed and controlled by law, with all influenced usually to a marked degree by professional ethics and state and local professional societies.

3. Restorative (rehabilitative) services by governmental, voluntary and private, profit or non-profit agencies, controlled to variable extent by state laws.

4. Promotive services, developed to a limited degree in this country by state and other agencies and devoted to maintaining or improving existing health through such additional means as housing, sanitation, recreational and educational facilities, and others.

What about authority? The Constitution of the United States makes no specific mention of health. We should stress that the fourth and fifth of six purposes stated in the preamble include "provide for the common defense, promote the general welfare," and there is a later provision that the Congress shall have the power to "provide for the common defense and general welfare of the United States." In keeping with the X Amendment, responsibility and authority of legislation to provide for the civil health are reserved to the respective states. Only a few State constitutions make reference to the public health; so, the civilian application of constitutional authority is by means of legislation, regulation and administrative directive by executives of federal, state and local governments.

What about civilian responsibility for civil health? The United States Public Health Service has one positively stated responsibility, the prevention

of interstate spread of disease. All other responsibility rests within the civilian administrations of the States.

Although elaboration upon detailed legal authority and responsibility of the military for civil administration must be left to others, we should discuss certain matters and situations in which military responsibility for civil public health is recognized. The nature of the military responsibility, as well as the attitude of the military, depends upon the policies established by the civil government for which the commander conducts the military operations. At home, authority is derived from civil laws, full accountability for the administration of which is assumed by the military commander along with that for administration of the military laws whenever he takes over direction or control of the civil administration. Abroad authority is derived solely from the fact of military occupation and not necessarily by conquering the country occupied. So long as the country or territory is occupied, the military commander has supreme authority, hence assuming the governmental duty of providing adequate health. But, we must repeat, the level of adequacy will be controlled by the policy of our government while it is applied to the community occupied by the military commander. It may extend from no aid to all-out provision of complete health services. The military governor may be limited to provision of no aid whatsoever to the occupied community, except to prevent disease or unrest which might be a menace to our own troops or to the objectives of the occupation. We have time for one clear example to show that military responsibility for the civil health involves also judicious recommendations to the government so policy may be established. You will appreciate the distinction between the military responsibility for the civil health as influenced by one food policy of our government towards the Germans in 1945 and that of today. The earlier policy permitted physiological survival, while the current one provides food to obtain work from the people in rehabilitating themselves.

In developing a civil health program the military must have a clear and exact concept of both short and long-term policy. They must know exactly what is desired of the civilian population in the way of political cooperations, as well as the production of essential goods. Let us go back to consider the food program. Along with all other health programs we must consider the physiological requirements of the individual in the job he is expected to perform. Just as important, it must consider also the psychological requirements. Foods and eating habits vary in their psychological value and may bear little relationship to physiological requirements. If cooperation of a civil population is essential to winning a war or a peace, these factors cannot be ignored. The commander may well call upon a medical staff officer qualified to aid him in such problems.

Without any effort at presenting extensive medical details, we should mention various circumstances under which civil public health becomes a military responsibility and list some examples, first at home, and then abroad.

"Military aid to civil authorities" is a process by which troops are used to aid in the reestablishment of orderly civil administration without proclamation of martial law. While such employment of troops at home is strictly prescribed by law, the Medical Department is authorized to treat emergency civilian cases to prevent loss of life or undue suffering. In general, the protection of life and maintenance of law and order within the territorial jurisdiction of any State are the primary responsibility of the State and Local authorities. Intervention with federal troops will take place only —

1. After state and local authorities have utilized all of their own forces and are unable to control the situation, or

2. When the situation is beyond the capabilities of state or local authorities, or

3. When state and local authorities will not take appropriate action, o

4. Under the provisions of certain statutes.

Except in cases of imminent necessity, intervention with Federal troops will take place only when the Department of the Army has generally or specifically so ordered.

In case of sufficiently dangerous public calamity disrupting normal governmental process or equivalent emergency which could not safely await action by the Department of the Army, an officer of the Army may take such action before receipt of instructions as the circumstances of the case reasonably justify. (1) His action may need to be prompt and vigorous, but should be for preservation of order and protection of life and property until proper instructions may be procured through his earliest possible report to the Department of the Army. Control, responsibility and authority involved in military aid to civil authorities apply to health as well as other administration of civil laws. Reasonable necessity is the measure of the military commander's authority.

One form of military aid to civil authority in which the Army has been responsible throughout our history is in disaster relief. In disasters or catastrophies, confidence in the military has always been manifest. While the employment of any part of the Army by state or local authority for the execution of ordinary civil laws is forbidden by act of Congress (2) and disaster relief cannot be undertaken by the Army without specific authority of Congress, Army Regulations direct the Army commander to use, solely under his command, all military personnel and military supplies in the affected area, with the exception of the National Guard and military supplies and equipment under the control of the governor of the State or Territory, to prevent starvation and extreme suffering. You will doubtless be impressed with the latitude given the commander here as in so many instances. He may undertake such measures as he deems necessary, provided only that local resources are clearly inadequate and supplies are issued only after their need is confirmed by the Red Cross, which agency is charged by Congressional Charter with disaster relief.

The President is authorized by statutes to employ, in his discretion, the military forces for enforcing customs and health laws (3) and quarantine and health laws. (4)

At home the most complete military responsibility for civil health would exist under martial law or military government. Martial rule, also termed "martial law", is the temporary government of the civil population through the military forces as necessity may require in domestic territory. It will not be proclaimed except by express direction of the President.(5) Military government is supreme authority exercised by an armed occupying force over the lands, properties and inhabitants of an enemy, allied, or domestic territory, when occupied by force or agreement and substituting its authority for that of the previous government. The control by the occupying force is limited only by the rules of international law and established customs of war. (6)

Wellington is reported to have said to the House of Lords that martial law is not law at all, but is merely the will of the commander of an armed force. Civil authority being ineffective, the government controls the civil population without authority of written law, as necessity may require. Martial law is proper only when the laws of the land cannot be duly enforced and must be terminated when the emergency is passed. (7) In martial law, there is no evidence that the military commander's responsibility and authority for civil health administration are limited, except by necessity, which is <u>actual</u> and <u>present</u>, for the safety of the Army and society.

Among the available examples of martial law, two are quite interesting, that of General Jackson in 1814 at New Orleans, and that of the Army commander in Oahu 7 December 1941. No health incidents have been found by me in the former, but the Commanding General of the Hawaiian Department maintained control of all civil functions to March 1943, when certain civil functions, including public health, were returned to the civil government. Large increases of troops and civilian employees, all in intimate contact with local civilians, created such extensive health problems as to be beyond the capacity of the Territorial Board of Health. The Army had to assist in sanitation matters for this migratory, expanded population, obtain clean-up of Honolulu by civilians (8), control rats and insects, solve sewage, waste and garbage disposal problems, and heavily fined civilian violators of orders in provost courts.

Health administration under martial law might be quite different from that of military government. The subjects of military government are the belligerent or other inhabitants of invaded and occupied enemy territory, foreign or civil, the occasion is war, and the field of government is the enemy territory. The subjects of martial law are fellow citizens or inhabitants not themselves belligerent or legal enemies, the occasion is public exigency in peace or war, and the field of government is that circumscribed part of our own country involved in the exigency. In military government the commander of the occupying forces is subject only to the laws of war and instructions to him from his home government. As a result he must prescribe such health administration, measures and activities as he deems proper. The health laws of the enemy may be adopted, revised or abrogated at will, partially or wholly. Much of this was done in Germany in 1945. In martial law, the local laws still apply, but temporarily cannot be enforced by local governmental machinery so the military commander would administer the local government health functions only for the period necessary to reestablish the capability of local civil officials for that administration. Officer and enlisted personnel are subject to civil courts in actions for damages or in criminal proceedings even in martial law.

Let us consider occupation and military government. (9), (10), (11). We have already defined it - complete military responsibility for all civilian health services exists under conditions of most occupations of foreign areas. If our forces occupy portions of an allied country, as in 1942-44 in the British Isles, responsibility and authority remain entirely with the allied civil administration, but our military must support and collaborate with that administration to the utmost. However, if forces otherwise occupy foreign territory there are several possibilities deserving our attention.

Our domestic experience of military government by a foreign enemy is limited to that by the British in Boston, New York and Philadelphia in the Revolutionary War days and Castine, Maine, in 1814. Our social pattern in those days presented no special health problems which were solved by the military. Military government of our own population by our own command occurred in Tennessee, Louisiana and Texas when those communities, for a time, constituted a public enemy by rebellion. Again, I have seen no evidence that the military government had peculiar health missions.

Occupation may anticipate retention and ultimate annexation. Examples in our history have been New Mexico and California, after the Mexican War and Porto Rico after the Spanish-American War. Authority here may not exist for maximum development of health services, but should be a goal from the earliest occupation.

Occupation may anticipate permanent separation of the occupied area from its former possessor with a view to its freedom to stand alone as soon as possible. Examples have been Cuba and the Philippines after the Spanish-American War, and the Philippines and Korea after World War II. Here the military responsibility would be for maximum development of civilian health services as necessary to protect our own occupying forces and to the extent possible for the civilian administration to develop for the population.

Occupation may anticipate neither retention as our own, nor separation from its own administration, as soon as the motive for occupation has been achieved. In World War II a term of "liberation" was applied to one type of friendly nation so occupied where the occupation forced out the enemy, gave our forces a friendly base for continuing operations against the enemy, but at the same time assured maximum support practicable towards re-establishing the nations' own administrations at the earliest possible time. Our forces had normally departed before this type of nation could become a participating ally. Examples in 1944-45 were France, Belgium, Netherlands, Denmark and Norway, and in 1945-46 the Philippine Commonwealth. There is a second type of nation which may be occupied without retention by us or separation from its former possessor as a goal but for some other motive. Examples are Mexico in 1846-47, Germany in 1918, Germany and Japan in 1945. In the liberated countries military responsibility for health affairs was complete during the occupation, but the entire period was characterized by re-establishing and supporting the civil administrations and prompt resumption of direction of their own civil affairs. In the enemy countries, also, military

responsibility for civil health affairs was complete. Here, however, there has been less support to the civil administrations.

The new civil administration has been permitted to develop its health service to the maximum possible, so long as all directives of the military governor have had compliance. There was no menace to the health of the occupying forces, and no interference with or endangering of the military government in its activities.

The military governor of a foreign occupied area will be expected to comply with existing directives to implement his mission by employment of military government teams set up for theater operations during and after combat.

The health missions are:

1. Control, prevention, and treatment of disease.

2. Rehabilitation and supervision of hospitals.

3. Furnishing of medical and sanitary supplies.

4. Protection of food and water supplies.

5. Disposal of sewage and waste.

6. Arrangements for the treatment and evacuation of wounded civilians.

7. Promulgation of such other medical and sanitary measures as are deemed necessary.

The last stated shows the limitless health responsibility involved in military government. Tables of Organization and Equipment prescribe the military government units with which the commander is expected to accomplish the health missions.

Let us repeat that a military commander has extremely wide latitude in military government, and in disaster relief, but his responsibilities are correspondingly great and he is governed by existing civil laws in administration by martial law. The critical conditions found after major disaster, after our invasion and occupation of enemy territory which has been attacked by us, or if our population has been attacked by any enemy dictates the need for the greatest possible understanding of these responsibilities.

What would be the military responsibilities for health in case our population were attacked by the enemy? The answer cannot be given clearly at this time, but the Office of Civil Defense Planning, established by the Secretary of Defense, 27 March 1948, is considering the extent to which civilian defense activities should be performed by regular and reserve military forces. If Federal or State martial law were invoked, the problem would be more clearly defined. But that would be contrary to a conclusion stated in the Report of the War Department Civil Defense Board (12) that civil defense problems are not appropriately military responsibilities. Pending final determination of responsibilities for health services, our experience in Hawaii in 1941 indicates that if a community were attacked by an enemy, military responsibility in the form of martial law might immediately exist for:

1. Increase of the usually required public health services.

2. Increase of the required therapeutic services.

3. Evacuation, hospitalization and medical and surgical care required for casualties, resulting directly or indirectly from the attack due to:

   a. Explosive effects
   b. Burns
   c. Chemical effects
   d. Radiological effects

4. Additional sanitation and preventive measures required because of:

a. Damage to existing sanitation facilities or exaggeration of existing sanitation problems.
b. Increased incidence of diseases.
c. Reduced availability of food or drink or their excessive exposure to bacterial, chemical or radiological agents.

You will agree that civil defense alone could present problems to the commander which would demand the most resourceful and ingenious administration. There are no military means of personnel, units, equipment or transport currently available or prescribed for such purpose.

To sum up, the foregoing has presented some concepts of military responsibility for civil public health. The public health, which was defined, was shown to be a community affair involving both civilians and military forces, and its great importance to the military command was stressed. The civilian responsibility and authority for administering public health were presented. Conditions and situations were suggested under which the military commander might become responsible for administering the public health for our own country under foreign occupation, under our own occupation, under martial law, and under conditions less than occupation or martial law, including also civilian defense. The conditions under which the military commander might be responsible for administration of the public health for friendly, allied and enemy foreign countries were presented. Finally, you will receive a list of references in which you may find exceedingly interesting material presented in a detail impossible for us in our limited time here.

In peace and war commanders of our forces have accepted grave responsibilities complicated by a maze of civil and military laws of many nations, and complicated by untold obstacles. Yet, they always have kept the faith. As military men, let us continue to guarantee that the civilians keep faith also. This is exceedingly important.

More than ever before, millions of civilians over the world seek civil administrations which will guarantee to them that dignity every individual deserves while he adjusts himself to a social order of steadily increasing complexity. From time to time the rights of all civilians and all civil administrations risk suppression by military force. May they still trust and look to you in confidence?

You will learn your responsibilities as our leaders of the past have done, and you will lead others to a truly public health. This will be assured if you will remember the dictum of Tacitus that "reason and judgment are the qualities of a leader."

REFERENCES FOR
RECOMMENDED READING

(1) Employment of Troops and Supplies
War Department Activities in
Connection with Disaster Relief,
AR 500-60, War Department, 1 Dec 1939

(2) Sec. 15, act 18 June 1878 (20 Stat. 152) as amended
10 U.S.C. 15; M.L. 1939, sec. 480

(3) R.S. 5316; 50 U.S.C. 220; M.L. 1939, sec. 491

(4) R.S. 4792; 42 U.S.C. 97; M.L. 1939, sec. 239

(5) Employment of Troops: Aid of Civil Authorities A.R. 500-50
Department of the Army, 17 August 1948.

(6) United States Army and Navy Manual of - Civil Affairs Military Government -
FM 27-5
Departments of the Army and Navy, October 1947

(7) Military Aid to the Civil Power
The General Service Schools Press, Fort Leavenworth, Kansas, 1925

(8) G.O. No. 137 Headquarters Hawaiian Department, 11 September
1942 - Historical Files, Office of the Surgeon General,
United States Army.

(9) Reports on the Law of Civil Government in Territory Subject to Military
Occupation by the Military Forces of the United States: Submitted to
Honorable Elihu Root, Secretary of War, by Charles E. Magoon, Law Officer,
Bureau of Insular Affairs, War Department.
U.S. Government Printing Office, Washington, D.C., 1902

(10) Military Government and Martial Law
William E. Birkhimer
James J. Chapman, Washington, D.C., 1892

(11) American Military Government of
Occupied Germany, 1918-1920
U.S. Government Printing Office, Washington, D.C., 1943

(12) A Study of Civil Defense
Report, War Department Civil Defense Board
Office of the Secretary of Defense, February 1948

(13) Directive, Memorandum from The Secretary of Defense,
27 March 1948, subject: Office of Civil Defense Planning.

(14) Medical and Sanitary Care of the Civilian Population Necessitated by
Attacks from Hostile Aircraft - William L. Wilson: Army Medical Bulletin,
Number 60, January 1942, Page 63

(15) Field Manual: Domestic Disturbances, FM 19-15
War Department, July 1945

(16) National Security Act of 1947
Public Law 253 - 80th Congress

(17) Functions of the Armed Forces and the Joint Chiefs of Staff -
Departments of the Army and Air Force
Joint Bulletin No. 13, 13 May 1948

(18) Military Government Service Organization,
T/O and E 41-500, Department of the Army,
3 June 1948

(19) The Administration of Occupied Areas -
Report by Major Robert H. Slover, Civil Affairs Division
Special Staff, Department of the Army, 1948.

(Reference on advice available upon request to the Author)

(20) The Army's Part in the Health Program of the Nation - Major General
Raymond W. Bliss, The Surgeon General, United States Army,
Army Medical Bulletin, Vol. VIII, No. 5, May 1948, page 341.

(21) Civilian Organization for Health in Time of War.
William L. Wilson
The Bulletin of the United States Army
Medical Department, Vol. VIII, No. 10,
October 1948 (In press)

UNITED STATES MILITARY ACADEMY, West Point.

Department of Military Hygiene

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Lecture VI

Malaria and Other Tropical Diseases of Military Importance

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MALARIA AND OTHER TROPICAL DISEASES OF MILITARY IMPORTANCE

18 and 20 September 1948

In studying the conduct of warfare, either as it applied to the past or as we try to foresee it in the future, it is common to analyze the opposing forces of the adversaries concerned and how their utilization results either in victory or defeat. The organization and training of troops, the available manpower, the industrial potential, the weapons employed, and the strategical and tactical utilisation of a nation's military strength occupy the primary interest of the usual student. Too frequently we overlook the factor of disease and to what extent it can weaken, cripple, or completely nullify the utilization of an otherwise strong and well-trained army. I regret to say that in our Army we have been guilty of this lack of knowledge or foresight. A few individuals during peace or prior to the outset of war have raised their voices in warning, but they have been unheeded. This was brought home to us during the early part of World War II, and of all the groups of diseases which seriously hampered our efforts, malaria and the other tropical diseases of military importance were the most serious. There is no doubt that these diseases, through ravaging our weakened manpower in critical areas, played a decisive role in our initial defeats and considerably prolonged the successful accomplishment of our early campaigns.

War in the tropical areas consisted not only of facing the well-trained and equipped troops of the Japanese, but also the jungles, the swamps, the stifling climate, insects, and fever. I would like to quote from the works of a soldier who had intimate experience with this situation. It is from GI JUNGLE, by Warrant Officer E. J. Kahn, Jr.:

> "The men at the front in New Guinea were perhaps among the most wretched looking soldiers ever to wear the American uniform. They were gaunt and thin, with deep black circles under their sunken eyes. They were covered with tropical sores ... They were clothed in tattered and stained jackets and pants ... Often the soles had been sucked from their shoes by the tenacious, stinking mud. Many of them fought for days with fevers and didn't know it ... Malaria, dengue fever, dysentery, and in a few cases, typhus, hit man after man. There was hardly a soldier amongst the thousands who went into the jungle who did not come down with some kind of fever at least once."

These were the conditions which faced many of our divisions, regiments and battalion during the early stages of the war. It is obvious that in order for the individual to carry on during strenuous combat he must be physically fit, and if otherwise, such as having fever, he not only is endangering his own life, but the lives of the entire unit.

Malaria is the most striking of all the tropical diseases that we are going to discuss today. By emphasizing the potential danger of malaria to a military force and by outlining briefly the problems of controlling this disease, I believe you will have some understanding of the effect of tropical disease in a military operation and the careful staff planning that has to be performed in order to overcome this enemy - an enemy as dangerous as the most highly trained and efficient enemy organization.

I will first briefly describe malaria as a disease. Malaria is caused by a very minute organism known as a "plasmodia," of which there are several different types causing specific clinical forms of the disease. It is transmitted from man to man by a species of mosquito known as the "Anopheles." This insect itself becomes infected with malaria by biting an individual harboring the plasmodia. Later, the mosquito transmits the infection to another person by its blood-sucking bite. After a relatively short lapse of time, fever develops and comes at periodic intervals, depending on the type of malaria concerned. There are three types which

infect man, two of which are encountered most frequently. One goes under several names, but today we will speak of it as benign tertian malaria. This name is somewhat deceptive, because I am certain that the patient suffering from the disease does not think it is benign in any way. The disease is apt to be prolonged for many months unless adequately treated, and it is probably these frequent relapses that cause the most damage. Malignant tertian malaria is the most serious to the individual because this is the form with the highest mortality. As I have stated, in either type the patient suffers with chills and fever occurring at periodic intervals. In addition, he is left progressively weaker as the disease continues so that he is unable to carry out his work during the intervals of no fever with the physical and mental energy with which he is normally accustomed.

Malaria has been known to exist for many centuries. The history of antiquity makes definite references to the disease, and undoubtedly malaria played a major role in the downfall of several civilizations in the Middle East and the Mediterranean basin. Today it still is the most important of all diseases. A report by the League of Nations in 1932 showed that in 65 countries, a total of 17,750,760 cases of malaria were treated in one year. But even more important: through its debilitating action it retards many extensive areas and even whole nations. I consider that a country like India will never be able to reach the degree of progress and individual well-being found in more advanced nations until malaria loses its vast hold over the population. In this country - India - with a population of 353,000,000 people, a study conducted over a decade ago showed that there were at least 100,000,000 cases in one year.

From this brief introduction it can be seen that prior to World War II we were well acquainted with the importance of malaria. In fact, our troops had been stationed for a long time in Panama and Puerto Rico areas which are highly malarious. We were able to eliminate the danger of malaria in those territories. Furthermore, this disease had been studied well throughout the world prior to the outset of war and we had complete information as to its potential danger in the various areas in which we could assume we would have to fight. It is amazing that with this knowledge and experience we were so unprepared.

Long before World War II our military authorities realized that Japan was a probable enemy in a future conflict. And as is common in maintaining military preparedness, our tacticians and strategists frequently projected the possible campaigns and battles through map exercises and actual maneuvers. The Japanese campaign that actually developed during their capture of the Philippines had been foretold in nearly exact detail. It was well known that the Bataan Peninsula would play an important role. Our troops had maneuvered up and down that peninsula against an imaginary enemy. At the same time it was known that Bataan was one of the most highly malarious areas of the world. However, the military importance of this disease was not recognized, at least to its fullest extent. As we look back we can see that it was a serious and fatal mistake. Plans to combat malaria and the dysentery diseases which likewise were prevalent on Bataan should have been given as great study as we did against the probable enemy action. For one thing, we should have included the evacuation of all natives from the Bataan Peninsula well in advance of the commencement of war. This may appear to be inhuman, since these people were our friends and looked upon us for protection; but these same natives were harboring a disease which as it proved later, contributed to our defeat to the same extent as did the Japanese Army. If we had removed such natives we would then have eliminated the source of infection from that area and thereby lowered significantly the number of infected mosquitoes. As it turned out, instead of carrying out such a radical but well-justified procedure, not only were the natives allowed to remain on the peninsula, but their numbers were increased by refugees from the surrounding countryside who sought safety within our lines.

Our records have not been compiled adequately and brought together to completely analyze the effect of disease in the fall of the Philippines. But from the accounts that have been written and from what men who were in that campaign are able to tell us, there is no doubt that the ravages of malaria and dysentery considerably shortened the period of resistance. We can say that Bataan was a failure to recognize the importance of disease in the outcome of a military campaign.

In spite of what was known to have happened on Bataan, it still took some time before adequate recognition was given to the importance of malaria. Following the loss of the Philippines, the remnants of our forces who escaped capture went to Australia and there a theater of operations was established and a mission presented. While malaria is not important on the Australian mainland, it was soon recognized that this theater - the Southwest Pacific - would have its initial operations to the north on islands which were known to be malarious. However, little or no recognition was given to this fact.

The First Marine Division which operated at the beginning of the campaign, left Guadalcanal in December of '42 and January of '43. At that time at least 80 per cent of the division was infected with malaria. Although they were brought back to a nonmalarious area for purposes of rehabilitation, they continued to have an exceedingly high number of malaria cases for months afterwards due to relapses. By August of 1943 the strength was fairly stabilized at over 20,000, of which 15,000 had served in Guadalcanal. About 500 cases were being admitted to the hospital each week for the treatment of malaria. This meant, considering length of hospitalization, that nearly 7 per cent, or 1400 men of the command, were in the hospital due to that disease. The importance of this can be appreciated further when we consider that attempts were being made at that time - nine months after being withdrawn from combat - to physically restore the men of the division and train them for further combat. With over 1400 cases in the hospital at any one time, it is readily realized how serious this was in retarding the restoration of the division to combat efficiency.

At the same time a similar example was taking place. Around the 1st of October 1942, the 32d Infantry Division had moved into New Guinea to engage in combat operations. They remained there until February 1943, when they were withdrawn to the Australian mainland. During the period - only five months - while the division was in New Guinea, over 5,000 fever cases were evacuated to clearing stations and hospitals, of which approximately 90 per cent, or 4500, were due to malaria. To further show the effect of this disease upon combat efficiency, during the early stages of the campaign admissions to the hospital for fevers increased from 4 per cent to 15 per cent of the command per month. In January 1943 the incidence became alarming, one-third of the command being in the hospital due to malaria. This was to be expected in troops who were beginning to show evidence of deterioration from malnutrition and long service in combat areas while at the same time little was being done to control the ravages of malaria. The consensus at that time was that the measures taken to control malaria were poor due to lack of equipment, and particularly to lack of training.

Not only had malaria seriously interfered with the efficiency of this division while it was in combat, but as we shall see, it continued its effect by prolonging the period of rehabilitation after the troops had been withdrawn from action. By June 1943, five months after the division had been evacuated to a nonmalarious area, the records show that over 2400 individuals within the division had had a primary attack of malaria, and of those, over 1700 had had at least one relapse, 674 had had two relapses, and 239 had had three relapses. These facts point out another striking action of malaria. Not only is it apt to hit the individual once, but it keeps coming back, or relapsing, which when on the grand scale as I have just described, seriously hampers the re-establishment of the division for combat utilization.

When this division was attempting to recuperate it had within the various regiments between 63 and 77 per cent of the men suffering relapses of malaria. At that time the division surgeon felt that men who had relapsed two or three times were of little value to the division. Having spent most of their time in the hospital, they were unable to participate in training. Their strength and physical endurance were far below that of the satisfactory soldier. Even on the assumption that they would not relapse again, it would be six months before these men would be up to combat.

The experiences of these divisions have been cited in order to show how disastrous the incidence of malaria can be in tropical warfare. Remember, at the time when these events were taking place our Army was trying to stop the

onslaught of the Japanese toward the Australian mainland. Also, it was essential that crucial areas like New Guinea must remain in Allied possession as bases for the long road back to the Philippines. The situation was critical in all its aspects. Supply routes were extremely long and exposed to enemy naval and air action. Most important, manpower trained for combat was limited. The Army was in no position to suffer the loss of combat troops from a disease which for the most part could be prevented.

Considering the strategical situation at this critical time, let us finally review the concurrent overall effect of malaria:

Four divisions - the First and Second Marine Divisions, the 32d Infantry Division and the Americal Division were noneffective for from four to six months after withdrawal from the combat area as a direct result of malaria. At the same time the 41st Division, then in New Guinea, was threatened with a similar fate. Reports indicated that the 14th Corps suffered a loss of 30 man-days per month because of malaria. In addition, through the evacuation of malaria patients, it lost the equivalent of an entire infantry battalion each month. Between October 1942 and April 1943, 30 per cent of all hospital admissions in this theater were caused by malaria.

In the light of these early experiences with malaria, authorities foresaw the necessity for the relief of combat troops at intervals of four months so that for every division in a malarious area there would be need for a second, more or less under hospitalization, and a third rebuilding for return to the unit. At this rate, about 250,000 men were required to maintain a force of 100,000 in a malarious combat area. Permanent losses from malaria were estimated roughly at from 2 to 4 thousand per month.

Gradually it was realized that malaria was an overpresent major threat to the success of military operations in large and important theaters of war. In certain highly malarious regions the enemy was a less menace to the effective strength of our fighting forces than was the malaria parasite. The length of the war could be assumed very well to depend upon the success of the antimalarial campaign.

The development of the solution for malaria is best exemplified in the experiences encountered in the South and Southwest Pacific. As the importance of this disease as a powerful factor in military campaigns was appreciated by the high command, progressive action began to take place. General Blamey, Commander of the Allied Land Forces, early in 1943 wrote to GHQ of the Southwest Pacific, suggesting that an advisory committee be established with representation from all the armed forces of the various allies. The Commander-in-Chief, General Douglas MacArthur, immediately took action by setting up the combined Advisory Committee on Tropical Medicine, Hygiene and Sanitation. This step was not the best that might have been taken, but it certainly was progressive and did lead to excellent results. It would have been better if there had been on General MacArthur's staff at GHQ a medical section with a chief surgeon at its head, upon whose shoulders should rest the final decisions in carrying out the extensive antimalarial program that was necessary.

At the time of the inception of this committee operations in New Guinea, in the Milne Bay and the Buna-Gona areas had been associated with an extremely high wastage from malaria of 33 per cent. Divisions in New Guinea and Guadalcanal were incapacitated and had to be withdrawn for rehabilitation within a few months after entering the malarious zone. There were inadequately trained troops, meager supplies of suppressive drugs, insecticides, repellents, and mosquito nets. How was that problem to be solved? The solution was the same as that which must be achieved by any field force operating in highly malarious areas.

There were, as there are now, three lines of attack. First, there are the sources of infection. Individuals, usually native, having resided for numerous generations in the community, have become highly infected. In their blood stream there is carried nearly constantly the malaria parasite. Because of their

long association with the disease, the evidence of malaria is not always manifested.

The second line of attack is the transmitter of the disease, the Anopheles mosquito, who breeds in the various bodies of water, and the female of the species who upon becoming an adult, is infected by biting the carrier of the disease and in turn passes her infection on to a susceptible individual.

Finally, we come to the third avenue of control - the protection of the individual soldier who can be safeguarded either by protecting him from the bite of the infected mosquito, or if, due to the exigencies of combat he does become infected, the clinical symptoms are suppressed by administering anti-malarial drugs.

We will now go back and consider briefly how these various general means of control can be employed. To consider first the source of infection, in warfare, in order to accomplish a military mission, harsh and even somewhat cruel measures are sometimes required. This is especially true in this case. The natives as much as possible must be removed from the areas in which our soldiers will either live or fight. By doing this we can be assured that there will be a marked reduction in a short time in the number of infected Anopheles mosquitoes. In turn, it is important to keep the troops away from concentrations of native populations in the neighborhood where Anopheles are numerous and the risk of transmission is correspondingly high.

Next we consider what measures can be taken to control the transmitter of the disease. The Anopheles mosquito breeds in all sorts of water. Some species prefer marshy, stagnant areas; others, swift-flowing streams; some, comparatively slow-flowing streams covered with shade - in fact, any water can be looked upon with suspicion. Following the initial onslaught of the Japanese it was realized that there would be a world shortage of pyrethrum as far as the Allies were concerned. Most of the lands in which this powerful insecticide was grown had fallen into the hands of the enemy. One of the most brilliant achievements of the war was the solution to this problem. Our Army, working with the U. S. Department of Agriculture, discovered a new insecticide more powerful than any previously known. You are all familiar with it. It is DDT. DDT was found not only to be effective in destroying the mosquito in the acquatic stages of its development, but also in destroying them as adults. Furthermore, it was shown to have something new - a residual effect. In other words, once applied, it remained effective for many weeks and even months afterwards. Armed with this potent weapon progress was assured in both preventing the large-scale breeding of the mosquito and also destroying them as adults.

As progress was being made rapidly in developing new insecticides, there were established tables of organization and equipment for two new important units in this type of warfare. They were known as the malaria control and survey units. Both units were to be used in the forward echelons, the survey unit to determine the incidence of malaria in the area and the breeding places and habits of the various species of Anopheles encountered. The control unit was to follow up immediately by eradicating the breeding ground through the application of DDT and other control measures and by destroying the adults through spraying huts and houses in native villages and the habitations utilized by the troops.

We now come to the third line of attack which in many respects is the most important. It is one which requires a high degree of education and training throughout the entire command. There must be the strictest discipline and the fullest realization by the command of its responsibility. These are the protective means which will be carried out by the soldier himself. They are important especially to the combat soldier; for while group or unit control measures, such as the application of DDT, are highly effective, such measures are difficult, if not impracticable to achieve while the troops are actively engaged in combat.

The well-trained and indoctrinated soldier can utilize various simple but effective means to protect himself. There is the mosquito net, which should always be used when the soldier is able to bed down for the night; the proper use of the uniform after sunset by keeping the sleeves rolled down and the

trousers at full length; and finally, there is the use of repellents. Considerable investigation was carried out during the war in the search for the best possible types of repellents. Several were found which, when applied carefully by the individual, would protect him for as much as two to three hours. There is also the use of particular equipment adapted for the dispersal of insecticide by the individual or small group - the hand sprayer, the well-known aerosol bomb. This equipment can be carried and supplied to any unit engaged in combat.

And finally we come to one of the most effective means of all, the suppression of the disease amongst actively engaged troops through the use of an antimalarial drug. The one we used in the last war was known as atebrine. Similar to the case of pyrethrum, the discovery of the effectiveness of atebrine was due to loss of the source of the previously well-known antimalaria drug, quinine. Through the combined efforts of the various Allied medical departments, particularly that of Australia and our own, atebrine was found to be a more effective drug than quinine in curing and suppressing malaria.

It is important to realize what is meant by suppression. It does not mean that it protects the individual from becoming infected with malaria - it is not a prophylactic. However, it does suppress the clinical symptoms of malaria as long as it is taken - the infected person has no symptoms of disease. In that way troops who would otherwise succumb to the ravages of malaria can remain in good physical condition. In addition, by taking such a drug and continuing suppressive treatment from two to four weeks after the troops are removed from a malarious area individuals infected with malignant tertian malaria, which causes the greatest mortality, will as a rule never have any clinical symptoms. This is not true for benign tertian malaria, where withdrawal of the drug is usually followed by symptoms.

Our experience during World War II proved that the adequate administration of suppressive treatment was in direct proportion to the degree of responsibility accepted by the command. Initially results were inconclusive. This was partially due to a fear of the drug. Unfortunately rumors were current amongst the troops that atebrine would cause a severe toxic reaction, jaundice and even sterility. It is true that many individuals when first placed on atebrine did suffer mild but annoying toxic symptoms, consisting for the most part of nausea and vomiting. However, these reactions with few exceptions soon disappeared. It is true also that there soon developed a yellowish discoloration of the skin, but this bore no relation whatever to jaundice or liver damage. It was merely a deposition of a dye in the skin which would disappear after a few weeks when the individual was taken off suppressive treatment.

The chief cause for the early failure of suppressive treatment was that the administration of the drug was left in the hands either of the medical officers, noncommissioned officers, or merely to the whim of the individual himself. Naturally, with such little supervision and discipline as this, many individuals failed to take their drug routinely. In order to accomplish adequate suppressive treatment it was essential that every soldier should take his pill once a day for every seven days of the week.

When through a series of brilliant experiments in Australia under the leadership of Brigadier N. Hamilton Fairley, Royal Australian Army Medical Corps, it was thoroughly proven that atebrine when taken consistently would suppress the symptoms of malaria regardless of the degree of physical activity of the soldier, the full value of this powerful control measure was accepted. Through command directive, suppressive treatment was enforced by placing full responsibility upon the commanding officers. Their troops were to take atebrine, and failure was indicated by an undue incidence of the disease within the command. It then became common for line officers other than medical to check the administration. In all areas where atebrine suppressive treatment was carried out in this strict way the results were dramatic. The incidence of malaria fell rapidly.

Today we have an improved antimalarial drug for therapeutic and suppressive treatment. This is known as chloroquine. The initial toxic reactions are milder and less frequent, there is no discoloration of the skin, and the drug need be taken only once a week for suppressive treatment. However, the discovery of this

new drug has not stopped our search for better antimalarials. Our goal is a true prophylactic drug - a drug which when taken by the individual will go much further than suppressing symptoms; it will actually prevent infection when the individual is bitten by an infected Anopheles mosquito.

However, this is not the complete story of malaria control. In order to control this disease effectively there must be active participation by all members of the staff within a major command. Just as in all other staff procedure, there is prior planning. The danger from the disease and its consequence to military operations must be recognized well in advance, and then through the various stages of planning the campaign the general staff and many of the special staff sections must play their part. G-1 is involved in considering the replacement that will be necessary due to malaria. G-2, with the help of the medical intelligence facilities, must determine the extent of malaria in the proposed area of operations. G-3 is involved in the training of all personnel - both officers and enlisted men, in essential basic knowledge of malaria control. G-4 is responsible for seeing that the necessary supplies are available. Prior to embarkation, all commanders must check to see that the troops have the necessary individual items for the control of malaria, including the ready availability of bed nets, repellents, insecticide materials such as aerosol bombs, hand sprays, DDT, etc. It is well that in every company there should be a malaria squad. Such men must know their jobs and be properly supplied. To do this it was common in the last war to establish schools for the purpose.

It is extremely important that all malaria supplies and equipment be top-loaded on the transports so that they will be immediately available to the troops following the initial assault. Too frequently in the recent conflict troops landed in malarious areas and were deprived of essential equipment to protect themselves for as much as four to five days or even longer than a week.

Malaria control and survey units are to be provided in suitable numbers and sent in during the initial stages of the assault. Such troops must not only have the necessary organizational equipment, but there must be readily at hand such items as placards and signs so that they can be placed at conspicuous places to warn the troops of the dangers of malaria.

Troop Information must be prepared to send forth constant propaganda through the radio, posters, pamphlets, etc. The Corps of Engineers have to carry out large scale control operations following the establishment of bases and camps. The Quartermaster Corps must be able to keep up a constant general supply of the necessary equipment and control items for which it is responsible.

If troops are to start from several areas either under the same major command or under separate commands there must be proper coordination in order that all may receive the same indoctrination and instruction that will be followed when they are brought under a single command during and following the initial operation. This latter feature was a big problem in the Pacific during the attack on Leyte. Some of the troops came up from the south, others came directly across from the Central Pacific. They were all to be commanded by General MacArthur. Naturally those troops that came from the Southwest Pacific had received proper indoctrination and training and carried essential supplies and equipment. However, those units from the Central Pacific, since they had not been under General MacArthur's command, frequently had not received proper instruction, or if they had, in some respects it was at cross purposes with that of the Southwest Pacific.

The control of malaria in the Southwest Pacific followed closely the procedure just described. It was a most difficult task, and required the utmost cooperation of all concerned. There was little or no benefit from past experience. Many of the essential parts of the control program were achieved through trial and error. In spite of extreme difficulties with supply, the training of personnel and the acceptance of command responsibility, the results were brilliant and served as a model for malaria control throughout the Army. As the control of the disease advanced in this theater, the role of malaria became less exacting. Control units became an integral part of forward echelons, and antimalarial work was recognized as an essential function in combat. Experience showed that malaria could be prevented and could be suppressed. Each soldier had to understand what the disease

was and how it could be prevented. Units in environmental sanitation and control were highly effective, but under combat conditions it was largely what the individual soldier did for his own protection. For these reasons malaria control became primarily a command function, necessitating the maintenance of a high degree of malaria discipline. Commanders who failed to enforce such control measures were shown to have jeopardized the success of the entire military mission. To the end of the war malaria remained a constant threat to the effective strength of the Army, especially in the Pacific. Although high, the toll which was encountered in 1943 was not repeated. Instead of as much as one third of the command being put out of action due to the disease, it was anticipated that in a well-disciplined and thoroughly indoctrinated division, less than 0.5 per cent should be expected to have the disease in spite of operating in highly malarious areas.

We can now see the broad implications involved in the control of malaria. It is not a matter for doctors alone; it is a matter of vital interest to every commander who desires to succeed in the accomplishment of his mission. It frequently involves critical decisions, since the control of malaria requires considerable equipment and supplies and troops specially trained to control the disease. In order to transport these supplies and personnel, it may be imperative to lower the priority of other equipment and personnel who likewise may be vital to the success of the campaign. This decision must be based on the calculated risk - in other words, can the campaign succeed in spite of malaria, or must there be assurance that this disease can be controlled? From our experiences during the last war, I should say that in highly malarious areas control of malaria is mandatory.

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SCRUB TYPHUS

During World War II scrub typhus proved to be a problem in both fixed installations and tactical operations in the Pacific and Asiatic theaters. It is true that it never became a disease of high incidence as in the case of malaria. Nevertheless, it did cause considerable alarm and concern to all personnel who operated in areas where the disease was prevalent, having a decided effect on morale. In this respect it can be compared to poliomyelitis. In the United States as we all know, poliomyelitis is feared by everyone. Similar to scrub typhus, it is not a disease that gains a high degree of incidence during epidemics -- not when it is compared to such a disease as influenza. However, the mortality is considerable and the after effects as we are well aware, are devastating to the individual. Scrub typhus does not have the after effects of paralysis, but in many instances the mortality from the disease becomes extremely high. It is a disease of high fever, a rash and generalized illness including headache, nausea and vomiting.

Scrub typhus as far as is known occurs only in certain islands of the western Pacific and parts of the Asiatic mainland. The disease is caused by a minute organism known as a Rickettsia. Varieties of Rickettsiae cause numerous other diseases, such as epidemic typhus, which was a serious problem during the early part of the Italian campaign in the vicinity of Naples.

The disease is transmitted by certain species of an insect known as the mite. The mite exists in this country where it is commonly called a "chigger," and in parts of the South, "redbug." The mite as a rule flourishes in grassy country, and attaches himself to man when the individual walks through the fields or otherwise exposes himself. It can readily be seen that the combat soldier can pick up the insect in an infested area, either during actual combat or in periods of quiet when he attempts to rest.

The mite, like the mosquito, searches for his human host in order to obtain a blood meal and it is through the blood-sucking bite that the disease is transmitted from the infected mite to man. The insect can become infected in nature by biting some animal who is harboring the disease. Our knowledge as to the animals involved is uncertain, but we suspect many found in the jungle, such as

rodents. Of serious importance is the fact that the disease is transmitted also by the mite to its progeny, thereby keeping the disease existent in the insects. This is not like the case of malaria, where the individual mosquito must always bite an infected person before the insect in turn is infected.

Our experiences during the war disclosed that scrub typhus appeared to be a disease of the grasses with some exceptions. It was more apt to be found around the periphery of jungles than deep within them. In establishing bases and fixed camps we soon learned to solve the problem of control by destroying the grasses where the mites were apt to be found. However, this task was not so simple when tactical troops were operating in endemic areas. From the work of the Australians it was decided that the impregnation of clothing was the best possible measure for the protection of tactical troops. We used the substance known as dimethyl phthalate. Clothing was impregnated for the most part by the mobile laundries of the Quartermaster Corps.

Before we learned the various measures for the control of the disease, it did cause serious effects amongst our troops in the Southwest Pacific and in the India-Burma theater.

In 1943 the 41st Infantry Division, reinforced by a regimental combat team and supporting artillery, aircraft and tanks, comprised the Biak Task Force. During the months of July, August and September a high incidence of scrub typhus prevailed, with the rate for July alone being one and a half per cent of the command. The control of this disease was further hampered by the fact that after organized Japanese resistance was broken, survivors retreated to the interior of the island where they had to be sought out by small American patrols for many months. This naturally complicated the problem from the standpoint of supply and the impregnation of clothing.

The Sansapor Task Force, consisting of the 6th Infantry Division supported by engineers and air corps units, encountered a similar situation. This was a small task force and suffered minor battle casualties. The attack was launched as reports from Biak had begun to indicate the seriousness of the typhus outbreak during that campaign. As in the other task force, assault units of the Sansapor force did not wear impregnated clothing, since its importance had not been recognized. Later attempts to impregnate clothing and to carry out mite control measures were difficult due to the factors of supply and a lack of training. Of the typhus epidemic encountered, it was found that the focal points of the epidemic were abandoned native villages which had once been cleared but had since become overgrown with rank, jointed grass. Since there was no combat, the choice of bivouac sites in and around native villages was purely on the basis of convenience. Although this task force had a relatively good health record otherwise, they did suffer a very high rate of scrub typhus — three and a half per cent of the command during the month of August and nine-tenths per cent during September. It was during this latter month when control measures began to develop.

The experiences I have just recounted amongst various task forces all occurred within the Sixth Army. During the period involved it was shown that scrub typhus was the most serious medical condition encountered. For the entire Sixth Army there were approximately 2287 cases reported, with a total of 60 deaths, or an overall mortality of two and six-tenths per cent. For the first time the disease constituted a serious threat and markedly affected the efficiency of certain units on Biak and Sansapor.

It is important at this time to mention another menace which is quite frequently overlooked but which did prove to be serious in the case of the task forces concerned. Normally we consider the contribution of disease to non-effectiveness — to loss of manpower and combat efficiency. This other factor which can have serious consequences is the effect of disease on the command and staff itself. In the case of Biak and Sansapor there was loss in this regard and in such small task forces this was enhanced, since replacements of adequately trained personnel were not readily available. We should pay more attention to this effect, namely, that a disease can be highly important if it is going to

knock out officers who in command or on staffs, are attempting to carry out a military mission.

There are several features of this disease which handicap us in control and estimation of its potential danger. It is difficult to determine where the foci of infection may be encountered. At one time scrub typhus was thought to be associated with kunai grass. However, it was found later where there was an abundance of low ferns and grass was sparse or absent. At Sansapor as I previously mentioned, abandoned native villages, former plantations or native gardens throughout which there was a rank growth of Bermuda-like grass, were associated with the infection.

Likewise we can never be certain as to the extent of mortality. At Biak, where there were over 1000 cases, mortality was less than one per cent. In Sansapor, on the other hand, there were 36 deaths out of 931 cases, or about 4 per cent mortality. These are a few instances where as many as 30 per cent of infected individuals died.

Before we leave the subject of scrub typhus I want to mention that this picture which I have just described has recently been modified. A new drug has been found which appears to be highly effective in the treatment of this disease. It is known as chloromycetin. Our Army recently sent a research group to Malaya where scrub typhus is highly prevalent. The results in about 40 cases showed that this drug, similar in some respects to penicillin and, like penicillin, is known as an antibiotic, appears to be a highly effective agent in the treatment of scrub typhus which as I have indicated before, frequently leads to high mortality.

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DYSENTERY AND DIARRHEA

Throughout the recent war and in all other previous conflicts, diarrhea and the dysenteries presented a serious and continuing problem to the Army. Susceptibility to these diseases is general, and the problem is further complicated by the presence in civilian populations and to a less extent in military, of individuals otherwise healthy who harbor the infection and excrete the cause of the disease in their feces and urine. However, our experience shows that despite their potential danger in military operations these diseases can be controlled by suitable sanitary measures.

During the last war the chief danger from these diseases existed in the principal tropical and subtropical theaters of operation - the Middle Eastern, the North African and the Asiatic. During the summer of 1943 in these three areas, over 11 per cent of the command were infected with one of the diarrheal or dysentery diseases. In the Asiatic theater between November 1943 and October 1944 they caused more admissions to the hospitals than any other disease, including malaria and the respiratory diseases. In addition, possibly many thousands were incapacitated by these diseases and were treated in quarters or remained on duty while ill and are thus not included in these rates. Therefore, these diseases caused an even greater loss in time and efficiency than would be indicated by the rate of hospital admissions alone.

Of these diseases, that known as common diarrhea constituted about 60 per cent of the total dysentery and diarrheal diseases during World War II. The remaining 40 per cent was made up of bacillary, amebic and other types of dysentery. In a typical case of common diarrhea the patient is not extremely sick. There is usually no fever and the illness lasts from three to four days, but there is considerable discomfort and impairment of physical efficiency through frequent and uncomfortable defecation. The specific cause of this infection is unknown, but a number of bacteria are suspected.

Bacillary dysentery has the characteristic of striking in epidemic proportions. The disease is caused by several known types of bacteria. The disease is not as a rule severe, and lasts for about ten days. The patient suffers from many uncomfortable reactions, including fever, cramps, and frequency of defecation.

Naturally such an individual who is attempting to stay on his feet cannot carry out his daily work and responsibilities in an efficient manner.

Of all diarrheal diseases and dysentery, the one which produced the most serious illness with the largest hospitalization and invalidism, the most serious complications, and the highest mortality and which is likely to be the greatest problem in the future, is amebic dysentery. In the Asiatic theater amebic dysentery constituted a larger proportion of all dysentery than elsewhere, amounting to 45 per cent of the cases. One of the most serious features about this disease is that it can pose a problem for both the individual and the community in which he lives for years after the initial attack. The disease is difficult to treat, and may reappear months or years afterward in forms which will cause hospitalization or even death. Frequently the individual is apparently cured but continues to discharge amoeba, the cause of the disease, from his feces. Through this means it can be spread to fellow members of his community.

The chief dangers of these diseases exist under field conditions in forward areas, especially in such places as the Pacific islands and Asia, where operations in territories heavily populated by peoples of primitive sanitary standards require command control if high losses are to be avoided. Unless individual and mass precautions are strictly enforced the most seasoned troops can be handicapped and impaired in their working and fighting efficiency.

These diseases can be transmitted by various means. Flies, food, food handlers and water are the chief agents involved. There is certainly a direct relationship between flies and the diarrheal and dysentery diseases. In combat areas, where large numbers of natives are carriers of these diseases, all sources of contamination must be eliminated if we are to prevent the spread of the diseases to the troops. In such cases as Africa, Asia and the Pacific islands, the disposal of human wastes amongst the natives which we can assume to be highly contaminated with the disease organism, is extremely primitive. Flies, which unless control measures are taken, are in abundance and will carry the fecal contamination to food and mess equipment. Too frequently the hazards of the fly were not recognized during the past war until dysentery had broken out amongst the troops.

Food is in constant danger of contamination from the time it is procured through storage, transportation and finally in its preparation and serving. Flies, which I have just previously mentioned, are one of the chief sources of contamination. I consider that next in importance is the actual handling of the food. During the recent conflict the employment of natives was very common both in and around army messes. Frequently it included using them in cooking and serving of food. In areas where diarrheal disease and the dysenteries were known to be endemic it was practically impossible to procure or select natives who were disease free. Therefore, this custom of employing natives was a constant menace to the health of troops.

The problems of maintaining sanitary discipline are constant, even amongst well-trained organizations. After a few hours in combat, even well-trained soldiers are apt to drink water from any source. It is difficult also while men are on leave or at railroad stations during long train rides to prevent their buying ice cream and cold drinks from unauthorized or questionable sources.

These conditions which favor the transmission of these diseases abounded in many of the theaters of operation during the last war. Frequently the results led to an unreasonable loss of manpower. One of the most extreme outbreaks of diarrheal diseases and dysentery was experienced in North Africa during the summer of 1943 at the end of the Tunisian campaign and in that period just prior to and including the later stages of the Sicilian campaign. During that time about 4 per cent of the entire command was admitted to the hospital per month suffering from these diseases. While the average patient lost only about six days when hospitalized, it was usually observed that a single unit would have the majority of their incidence within one outbreak. Such a loss, even for a short time, might very well occur at a crucial period when the organization was committed to combat. The effect on the military mission is obvious.

Certainly the aspect of training is one that cannot be neglected at any time. The time for teaching sanitation is prior to exposure to the hazards and not when troops are faced with the terrific mental and physical exigencies of combat. The high incidence of diarrheal diseases and dysentery indicates a lack of discipline which in turn comes from lack of training.

Similar general measures of control apply to all dysentery diseases. The infected food handler in both the civilian establishment and army messes must be eliminated as a hazard. When native labor must be used they should be prevented from having any contact with prepared food and eating utensils. Hand-washing facilities should be provided at latrines for native help as well as army personnel. Civilian facilities should be looked upon with great suspicion and the Army should endeavor to provide its own attractive eating establishments and entertainment for Army personnel. In tropical or backward areas foods that are to be served raw should be thoroughly disinfected prior to consumption. Providing a safe water supply is essential. So important are the duties of personnel on water details, operating chlorination and filtration units, that the command must exert its authority to the lowest echelon in assuring such a supply. Flies and other insects which can mechanically carry the disease to food and eating utensils must be thoroughly controlled. As in the case of the mosquito, DDT is an effective agent in preventing the breeding of flies or destroying them as adults.

Although I have just mentioned most of the important ones, I should like to enumerate briefly those control measures which must be strictly enforced. They are: the prohibition of the consumption of unauthorized food and water; sanitary control of camp sites and facilities; careful selection and supervision of all personnel connected with food handling and dispensing; control of flies; treatment of water; disinfection of raw fruits and vegetables; proper sterilization of mess utensils; and rigid individual sanitary discipline based on thorough training.

The effectiveness of this program will vary with combat activities and environment, but if efforts are exerted to the greatest extent that the situation allows the control of diarrhea and the dysenteries will be accomplished.

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SCHISTOSOMIASIS

Schistosomiasis is the final disease we will consider today. From our experiences during the last war, it was not a serious disease as far as loss of manpower was concerned, but it did bring out something that was rather new and which complicated its control, namely, attempts to thoroughly train personnel prior to exposure to the area where this disease was prevalent would have violated security.

Schistosomiasis is caused by a schistosome fluke. It is an organism larger than bacteria, but has to be viewed under a microscope. According to the type of schistosomiasis concerned -- of which there are several -- there can be a variety of symptoms, including infection of the bladder, abdominal and dysenteric symptoms. The schistosome leaves the body through the urine or feces and enters a body of water where it infects snails. The snails become infected and the organism is ejected back into the water in a stage of development where again it can enter man by piercing his skin. Therefore, we can see that when individuals bathe, wade, or work in water contaminated with the schistosome they can acquire the infection by the schistosome passing through their skin into the body. Clothing gives no protection from this invasion. The disease has been studied for a number of years and it has been found that schistosomiasis is endemic in certain specific localities. It may be on one side of a mountain range but absent on the other, a valley may be the dividing line. These facts have become common knowledge, and many of the actual localities were known to both the Allies and the enemy.

The initial plan for the attack on the Philippine Islands included a landing on Mindanao and thereafter moving up the entire archipelago. Shortly before the

anticipated onslaught of this campaign the joint Chiefs of Staff considered by-passing the Philippines and landing at Formosa. This idea was opposed by General MacArthur and his staff and the result was that it was decided to have the initial attack on the beaches of Leyte. The campaign included the element of complete surprise to the Japanese. At the time it was known that Japanese forces were concentrated in the vicinity of the various possible landing beaches available to our armies. The slightest preliminary warning to the enemy would have allowed him to pull his troops out of the areas which were not to be attacked and to concentrate on the beaches indicated by our action.

Schistosomiasis is not endemic throughout the Philippine Islands, but is located in certain definite areas, and as I have said, such information was well known to everyone. I think you can understand now the difficult problem which arose as to how we could protect our troops from this disease. It was impossible to institute full control procedures, particularly training and the use of equipment, prior to embarkation of troops for this operation. If we had done so, enemy agents would soon have recognized what we were doing and the Japanese authorities, upon receiving such information, would have had a clear indication as to where we intended to land.

This was a unique situation in preventive medicine where the control of a disease was limited by military security. The problem was partially solved by not beginning the indoctrination of troops until they had embarked on the transports. Until just prior to the assault, directives, educational material, etc., had to be withheld from all concerned, including medical officers and units who would have to carry out and supervise such measures of control.

Following the landing, the troops had to advance through waters highly contaminated with the disease. The situation was made worse because the landing occurred during the rainy season, when all the rivers were up, lakes and ponds were overflowing and bridges had to be constructed. Engineer personnel working in such waters naturally became infected. Troops who had to wade through contaminated water suffered likewise. Due to lack of proper training and indoctrination there were several striking examples of carelessness. An Air Force unit camped near a body of water, having seen women washing clothes, thought there was no danger and went bathing. The result was a very high incidence of the disease in this unit. In short, during this campaign there were over 1200 cases of schistosomiasis. It is true that such a number was not serious, considering the thousands of troops involved. Probably it was just through good fortune that we did not suffer more.

* * * * *

The discussion has been limited to four tropical diseases which from past experience have seriously affected military operations. They are only a representative sample. Time does not allow me to mention many other tropical diseases which have or could in the future directly or indirectly influence the outcome of combat. Japanese B encephalitis, cholera, leishmaniasis, plague and several other diseases are frequently encountered in tropical and subtropical areas in such proportions that if a military command becomes infected there may be a serious loss of manpower. However, from discussion of the four diseases mentioned today I trust you can appreciate the seriousness of tropical diseases from a military viewpoint. Most important is the realization that control of these diseases rests upon command action.

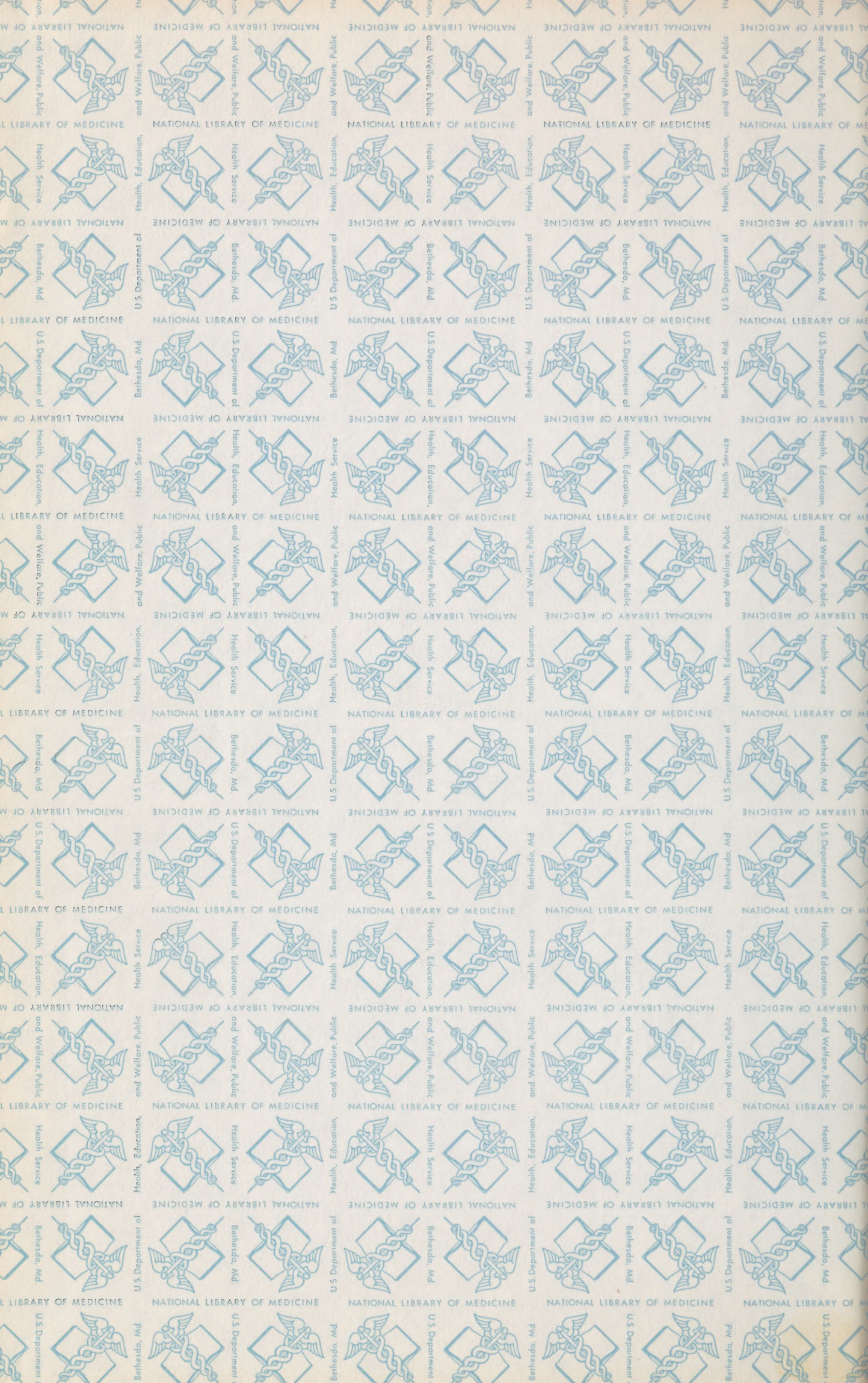
I believe it is safe to foresee that our Army will not suffer again from the effects of such diseases as malaria to the extent encountered during the early days of World War II, when the results of this disease were nearly catastrophic. During the recent war through extensive investigations we made great advances in the control not only of malaria, but nearly all the other diseases found in the tropics. More important, this progress has not stopped with the cessation of hostilities. Today in this country and in many other parts of the world we are carrying on research and development for the purpose of finding new and improved methods for controlling all of these tropical diseases as well as communicable diseases in other climates. Certain notable results have been attained. I have

already mentioned chloromycetin, the new drug for the treatment of scrub typhus; chloroquine for both the clinical treatment and suppressive treatment of malaria. Work sponsored by the armed forces and performed by the U.S.Department of Agriculture has resulted in the discovery of new insecticides, several of which are effective against insects against which DDT has little or no effect. Ticks and mites which were always a problem during World War II now appear to be susceptible to some of the newer insecticides.

We are also constantly studying and improving our operational means for the control of these diseases. Our malaria control and survey units are being reconstituted. They will be given broader scope and better tables of organization and equipment. Our laboratories in all parts of the world are developing and utilizing new methods for the detection of the insect vectors and the diagnosis of the disease in the patient.

All this work which has been developing during and since the war is representative of cooperative effort throughout the Army. It may surprise you to know that the Medical Department would be unjustified in taking full credit for this work. The true picture is one of teamwork between many of the technical services. The Corps of Engineers, the Quartermaster Corps and the Chemical Corps as well as the Medical Department have been actively engaged in all these phases of tropical disease control. The Corps of Engineers are concerned with methods and equipment used for controlling all insects and rodents and water supply and purification, since such matters are their responsibilities. The Quartermaster Corps procures and issues many of the supplies and equipment utilized in the control of these diseases. They are responsible for the procurement of safe and adequate food supplies. Also the development of protective clothing is their concern. The Chemical Corps in the past and today, is noted for its brilliant research in discovering newer toxic agents for the control of insects and rodents and the mechanism of action of such compounds.

However, all this work toward discovering better methods for the control of disease will have little or no effect if command responsibility fails to be fully accepted. This is one of the reasons why you are receiving at this time a series of lectures on common Medical Department subjects. I hope from what I have said today that you can begin to appreciate that the attainment of disease control depends upon the command and staff, realizing the dangers of disease and accepting the calculated risk, will then direct all practical measures for control which are consistent with the military effort.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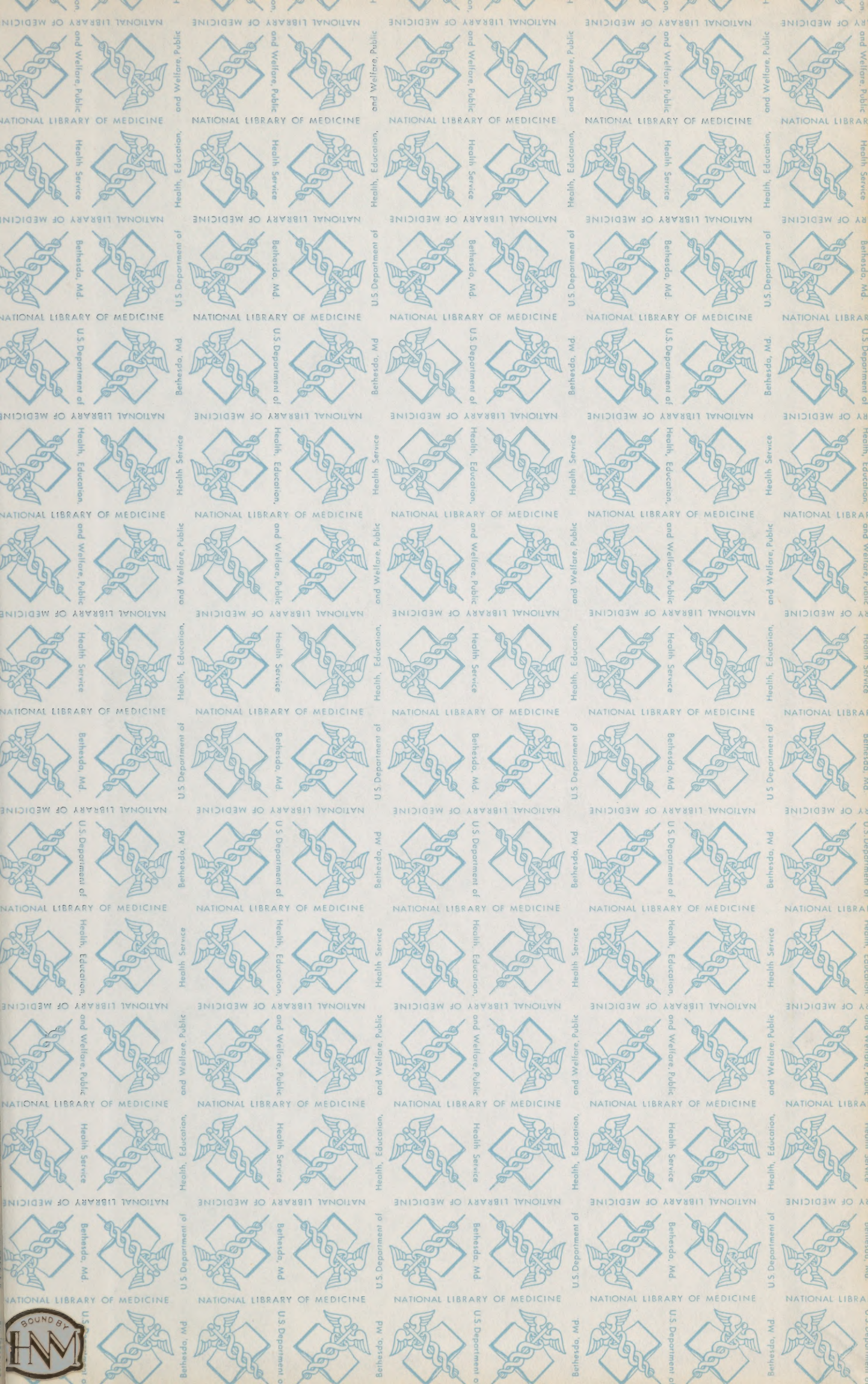
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